

REPORT
ON THE
FORESTS OF BALUCHISTAN

BY
SIR HAROLD GLOVER
JULY 1944.

PUBLISHED ON 1ST SEPTEMBER, 1944.

LIST OF CONTENTS.

Serial No.	Subject.	Para.	Page.
TEXT			
1	Introduction	1	1
2	The Inspector General of Forest's report	2	1
3	Administrative history	3	1
4	The present Forest Officer	4	2
5	The Chief Forest Officer	5	2
6	Physical characteristics	6	2
7	Climate	7	3
8	Rainfall	7	3
9	Area statement	8	4
10	The economic back ground	9	4
11	Firewood and charcoal	9	5
12	The demand for Forest Produce	10	5
13	Pencil and Cedar	10	5
14	Juniper Berries	10	5
15	Ephedra	10	5
16	Pyrethrum	10	6
17	Artemisia	10	6
18	Chilgoza nuts	10	6
19	Asafoetida	10	7
20	Drugs and Medicinal herbs	10	7
21	The distribution of trees to Right Holders	11	7
22	Legal	12	7
23	The area of Forests	13	8
24	The function of the Forests	14	9
25	Grazing	15	9
26	Grazing in the Forest Reserves	15	10
27	Tirni	15	10
28	The effects of the disappearance of the forests	16	10
29	Climax types of Forest in Baluchistan	17	10
30	The Juniper Forest	18	10
31	The present Forest Reserves	18	11
32	The <i>Guzara</i> forest	18	11
33	The Olive Forest	19	12
34	The climax type	19	12
35	The present forests	19	12
36	The karil and bata forester	20	12
37	The upland valleys	21	12
38	Tamurisk forests	22	13
39	The stony torrent bed	23	13
40	Cultivated trees	24	13
41	General	25	13
42	Cultivation	26	14
43	Perennial irrigation from springs and streams	26	14
44	Perennial irrigation from <i>karez</i>	26	14
45	Inundation from the rivers	26	15
46	Inundation from torrents when in floods	26	15
47	Fields formed by blocking valleys with earthen dams	26	15
48	Dry cultivation in embanked fields called Khushkaba	26	16
49	The process of levelling	26	16
50	Dry cultivation without embankment in Pishin district	26	16
51	Soil erosion in Pishin district	26	17
52	Use of tractors for Khushkaba cultivation	26	17
53	Road drains and spurs	27	18
SUMMARY			
54	Soil erosion	28	19
55	The extent of erosion	28	19
56	Erosion due to water action	28	19
57	Wind erosion	28	19
58	The causes of soil erosion	28	20

Serial No.	Subject.	Para.	Page.
59	The cure for soil erosion ...	28	20
60	Policy	29	20
61	A planned rural economy ...	30	20
62.	The means of giving effect to the policy ...	31	20
63	Propaganda ...	31	21
64	The forests ...	31	21
65	Suggestions for technical management	32	21
66.(1)	The Juniper forests	32	21
67 (2)	The olive forest ...	32	21
68	For grazing alone ...	32	21
69	For fuel and grazing combined ...	32	21
70 (3)	The <i>Phulai</i> forest	32	22
71 (4)	The Tamrisk forest and ravine bed.	32	22
72 (5)	The pasture	33	22
73 (6)	The low scrub forest and the pastures	34	22
74	Grazing by migratory flock	34	22
75	Jirga forests and pastures ...	35	22
76	Cultivation ....	...	23
77	Present action required ...	36	23
78	Future development ...	37	23
79	Immediate improvements required in present Forest Department Organisation ...	38	24
80	The Chief Forest Officer ...	39	24
81	The executive subordinate staff ...	39	24
82	Appointments to grades Forester and upwards ...	40	24
83	Appointments of Forest Guards ...	41	24
84	Travelling allowances ...	42	25
85	Office Staff ...	43	25
86	Firewood supply ...	44	25
87	Irrigated Fuel plantations ...	44	25
88	Water requirements ...	44	25
89	Soil ...	44	25
90	Situation	44	26
91	Temporary cultivation	44	26
92	Establishment required ...	44	26
93	Finance ...	45	27
94	The Financial position ...	45	28
95.	Stocks ...	45	29
96.	Outstandings ...	45	29
97	The Surplus ...	45	29
98	The budget 1944-45 ...	46	29
99	Roads and bridges ...	47	29
100	Buildings ...	48	29
101	The economic implications of the forest budget expenditure ...	49	29
102	Possible developments ...	50	29
103	Firewood ...	50	29
104	Pencil cedar ...	50	29
105	Ephedra ...	50	29
106	Pyrethrum ...	50	30
107	Drugs ...	50	30
108	Conclusion ...	51	30

APPENDICES.

I.	Statement of Forest Rangers, Deputy Rangers and Foresters required ...	(i)
II.	The Zhob District ...	(ii)
III.	The Chagai District ...	(iv)
IV.	Diary and tour notes ...	(viii)

REPORT ON THE FORESTS OF BALUCHISTAN

BY

SIR HAROLD GLOVER, JULY 1944.

1. Introduction. In memorandum No. 3693-E/43 dated 4th December, 1943 addressed by the Deputy Secretary to the Government of India in the External Affairs Department to the Honourable the Agent to the Governor General, Resident and Chief Commissioner in Baluchistan sanction was given to my employment after retirement from the Indian Forest Service for a period of from two to three months to report on and reorganise the administration of forests in Baluchistan.

On arrival at Quetta and on many occasions subsequently I had the advantage of discussing forest administration and policy with the Honourable Lt. Col. W. R. Hay, C.S.I., C.I.E., Agent to the Governor General, Resident and Chief Commissioner in Baluchistan, with Mr. Hopkinson, I. C. S., Revenue Commissioner and with Mr. H. Weightman, I C.S., his successor. I also met and discussed forest administration and soil conservation with the Political Agents of each district, all of whom were interested in forest matters and were most helpful. I am most grateful to the above mentioned officers and to the Baluchistan Administration for their assistance.

It was agreed that my report should not be limited to forest management, but should deal with soil erosion throughout Baluchistan and should suggest methods for conserving the soil.

Attention is invited to two publications on soil erosion and conservation, which are now in the press: Soil Erosion published by the Oxford University Press, Bombay. Pamphlet No 23: price six annas. A survey of Soil Conservation in the Punjab. The pamphlet should be in the hands of all Revenue Officers and English knowing subordinates: copies of the Punjab Survey should be obtained for the Secretariat and district libraries.

2. The Inspector General of Forests' report. In August 1940 Sir Herbert Howard, Inspector General of Forests, toured in Baluchistan and suggested that forest administration needed thoroughly overhauling. He found it extremely difficult to obtain any information as to the past history of the forests and on the methods of management and administration. He drew particular attention to the menace of soil erosion and he suggested, amongst other matters, the expansion of the forest reserves to the whole area covered by tree growth, the closure to browsing of the undemarcated forests in rotation, the management of all waste land by the Forest Department, and the appointment of a Chief Forest Officer of Imperial Forest Service standard. The forest policy was to be suggested by the Chief Forest Officer and a preliminary working plan report was to be written. No serving officer was available and a Forest Ranger on deputation from the Punjab is now in charge of the Baluchistan Government Forests.

3. Administrative history. Even before the 1935 Quetta earthquake it was extremely difficult to obtain any connected history of the forests: now it is impossible, although search through the godowns of old unsorted records might reveal something of historical value. The following notes have been compiled from District Gazetteers, from my tour notes of 1925, from files and from the Inspector General of Forests' report, and are approximately correct.

The first Forest Officer stationed in Baluchistan was Mr. J. H. Lace, F. L. S., who from 1885 to 1887 compiled a flora of Baluchistan of which

there is a printed copy in the office of the Chief Conservator of Forests, Punjab. Mr. Elliot visited Zhob in 1892; Mr. Down was Chief Forest Officer until 1904 when Bhai Sadhu Singh, Extra Assistant Conservator of Forests assumed charge and later on was relieved by Lala Bakhshi Ram, Extra Assistant Conservator of Forests. In 1923 the Government of India suggested that in view of the small revenue and the very limited programme of afforestation a senior forest ranger might replace the Extra Assistant Conservator of Forests, and that the Baluchistan forests should be inspected once every two years by a Conservator from the Punjab. Lala Bhag Ram, Forest Ranger, took charge of the forests in 1923 and I inspected the forests in 1925, and a printed copy of my report still exists. The forests were not again seen by a senior forest officer until Sir Herbert Howard's visit in 1910. Lala Bhag Ram was succeeded by S. Jagatjit Singh, Forest Ranger who was followed in 1933 by Qazi Hafiz-ud-Din, Forest Ranger who retired in 1943 when he was relieved by the present Forest Officer, Ch. Mohammed Sulaiman Khan, Forest Ranger.

4. The present Forest Officer. Ch. Mohammed Sulaiman Khan has been hampered by the lack of records, and of a defined forest policy, and of any sort of working plan or scheme; coupled with an undisciplined, inefficient and untrained forest staff. Since Sir Herbert Howard's visit there has been a greatly increased demand directly or indirectly due to the war for ephedra, for timber for pencil making and for firewood, and the wonder is that Ch. Mohammed Sulaiman Khan should have been able to carry out satisfactorily the vastly expanded routine and day to day duties of the Forest Officer. Had he not possessed great energy and character he would not have been able to have done so, hampered as he is by not having had previous experience of holding charge of a forest division in the Punjab, or of possessing the status and qualifications of an I. F. S. or P. F. S., I officer.

5. The Chief Forest Officer. We see that there has been a great decrease in the technical qualifications of the Forest Officer, from a Deputy Conservator of Forests from 1885 to 1904 to a Forest Ranger for the past twenty one years, with one inspection in 1925 by a Punjab Conservator and none since. Small wonder is it that the Inspector General of Forests commented very adversely on the management of the forests, or lack of it, when he visited Baluchistan in 1940. Sir Herbert Howard suggested that an Imperial Forest Officer was required. This is most desirable, provided that one can be found who is suitable, is willing to come and who can be spared.

6. Physical Characteristics. The regional geography and geology of Baluchistan have been described in the Gazetteer and in my tour note of 1925. Baluchistan is an eastern continuation of the Persian plateau and lies between Persia and the valley of the Indus. The country is mountainous with high upland valleys which form long stretches of flat or gently sloping land walled in by barren looking hills.

The formation of these upland valleys is due to the low rainfall which is insufficient to carry away detritus: conditions are changing slowly as, owing to deforestation and the reduction of the already scanty vegetation by heavy grazing, the rate of run off of storm water is now greater than it was when the upland valleys were formed. There is sheet erosion on all hill sides and there are wide stretches of naked sheet rock; where the underlying rock of the hills consists of clays or detritus there is gully erosion: on the upland valleys sheet erosion is universal: on the edges of the main drainage channels ravines are extending into the plateaux, particularly in the Quetta-Pishin district: the torrents descend their stream beds in the hills with increasing violence and when they reach the plains spread out in fans and form numerous channels, behaving in a manner similar to that of torrents in regions of greater rainfall, as described in my Survey of Soil Conservation in the Punjab, now in the press.

In the Nasirabad tehsil of the Sibi district, which borders on Sind, there are large alluvial plains which recently have been irrigated by the Indus canals and are now cultivated: the irrigation of other lands in the Indus valley is contemplated.

1. Climate. The climate of Baluchistan is one of extremes with severe cold in the winter at high elevations and intense heat in the summer at the lower elevations, particularly in the low foot hills and the plains where shade temperatures reach 126°F. At higher elevations the day temperatures are high in the summer but the nights are always cool. In the winter the climate is cold and snow falls. Long periods of drought and high winds are particularly unfavourable to vegetation.

Rainfall.

The rainfall, increasing with elevation, shows marked variations depending on situation throughout the year. Usually the wettest months are January, February and July, followed by long periods of drought which occasionally are broken by storms of tropical intensity when much rain falls in a very few hours. Some statistics of rainfall taken from recent records are of interest:—

Place.	Altitude	January 1942	February 1942	July 1942	Total	High daily rain.	
						1942	1944
Sibi Alt: 500'	Normal 1942	... 1.21	... 0.53	... 2.35	... 4.76	... July 2nd 1.54	
Harnai alt: 8000'	Normal 1942	0.81 3.30	1.06 3.47	3.07 10.18	13.34 24.09	July 8th 2.12 July 17th 2.37	
Loralai alt: 4500'	Normal 1942	0.90 1.78	0.95 2.40	1.37 1.21	9.05 8.24	... ...
Fort Sandeman alt: 4700'	Normal 1942	0.60 2.19	0.94 2.39	2.26 3.70	10.95 10.86	... July 7th 1.74	
Quetta alt: 5500'	Normal 1942	4.14 1.39	1.99 1.36	0.84 0.05	9.97 6.03	... ...	March 25th 0.90
Nushki alt: 3000'	Normal 1942	2.70 0.82	1.51 0.95	0.21 0.08	8.40 3.72	... ...
Dalbandin	Normal 1942	1.21 0.90	0.61 1.08	0.06 0.17	3.45 6.84	... ...	March 25th 1.40
Mastung	Normal 1942	... 5.68	... 1.81	... 0.61	... 14.41	... ...	March 26th 3.17 10-1-43 2.77

	Highest daily rainfall		Normal yearly	
Pasni	3.07	18-1-39	6.14	(Makran)
Khost	1.75	21-2-39	8.93	
Spintangi	1.75	26-2-39	9.41	
Sanjawai	2.45	22-3-39	10.78	
Duki	2.12	14-2-39	9.92	
Sanzala	3.00	26-2-39	10.61	
Shahrig	2.60	17-7-39	13.21	
Gandawa	2.75	6-7-41	4.25	
Nakas	9.00	21-7-41	11.92	
Harnai	3.04	21-7-41	13.34	
Urak	1.73	22-1-44	13.26	
Barkhan	1.00	22-3-44		
	1.27	2-4-44		
	1.50	7-6-44		
Musakhel	1.60	26-4-44		
Khushdil Khan	1.70	Jan: 44		
Kolpur	3.00	11-1-43	9.08	

8. Area Statement. The following statement gives the distribution of the various classes of land by districts :—

District	Total area in square miles	Population per square mile 1941	Notified forests in square miles	Cultivated area	
				Rabi	Kharif
				1942-43	
				Aores	Aores
Quetta-Pishin	5,310	29	144 <small>Includes Pishin Kharif 34 sq miles</small>	68,687-2-0	10,580-1-0
Loralai	7,375	11	104	60,336-0-0	35,225-0-0
Zhob	10,478	6	7	18,288-2-0	7,403-1-0
Bolan	407	15	....	365-0-25	103-2-27
Chagai	19,429	2	1,404	18,049-3-0	4,396-2-0
Sibi	11,457	14	109	1,36,820-1-24	1,37,532-0-4
				Square miles.	
Total	54,406	9	1,768	473	305

9. The economic background. The rural population is expanding only slowly, if at all, in marked contrast to other parts of India. The people are indolent, do not join the Army, take service in local levies, are uneducated and have not advanced greatly in the past 50 years.

The hill tract, excluding the irrigated plains of the Sibi district, has a population of only 8 persons per square mile, widely distributed in small villages or nomads' encampments in upland valleys separated by steep hills. The small numbers of the people and their sporadic distribution make all kinds of administration, inclusive of that of the forests, both expensive and difficult.

Before the British occupation in 1879 little land was cultivated as life and property were unsafe. Shepherds were able to hide their flocks in the recesses of the hills; and the main business of the country was grazing. With the increasing peace and security of recent years more people have taken to agriculture, but, partly owing to the dry climate and difficulty of irrigation, there is far more land available than there are men to cultivate it.

There are fine fruit orchards near Quetta and Loralai irrigated by *karez*, artesian wells or permanent water channels, and there are cantonments at several centres which have created a local demand for firewood, animal products and for labour. There are coal mines, which owing to the low quality of the coal are not greatly developed, chrome ore and sulphur mines, but the main industry of the country is grazing. This matter of grazing and its effect on the pastures and soil erosion will be referred to again and again in the course of this survey, but no apology is made for repetition in view of its dominating importance in the rural economy of the Province.

Firewood and charcoal.

10. The demand for forest produce. There is a demand in Quetta and in Cantonments for firewood and charcoal which is greater than can be met from the hill forests. Firewood and charcoal are imported from Sind and only cut or burnt in the hill forests to meet emergencies; but the temptation to cut trees in the forests is increasing owing to the difficulties of transporting bulky fuel from the plains by train.

The main supply of firewood is from the inundated forests of Sind, but that supply is diminishing and Quetta has to compete with the rich cities of Lahore, Amritsar and Simla, both for firewood and charcoal.

Fortunately Baluchistan has coal mines, which although not gratefully developed produce coal of low quality (it contains sulphur) which should replace firewood wherever practicable. The gross value of the sales in 1943-44 was Rs. 1,02,904.

Pencil cedar.

During the war there is a demand for juniper wood for pencil making which is far greater than the forests will be able to meet, should imports from East Africa be discontinued for more than two or three years. The trees are branched, their timber is knotty, the grain is twisted and only 5% of the timber of selected logs is turned into pencil slats. The rest is wastage or is sold as firewood at prices which just cover the high costs of delivery at Quetta. The demand is confined at present to dry trees of which there are quantities in the forests, but the nearer areas are likely to be exhausted within 3 years. The gross value of the sales in 1943-44 was Rs. 9,592/-.

Juniper berries.

There is a limited demand for juniper berries for flavouring gin and for tanning. The berries are collected under license and are sold to the Forest Department which has a monopoly of sales to traders.

The gross value of the sales in 1943-44 was Rs. 11,056/-.

Ephedra.

Baluchistan produces ephedra of high quality, for which the demand during the last few years has greatly increased as is shown by the following statement of revenue and expenditure taken from the Forest Department books :—

	1937	1938	1939	1940	1941	1942	1943
Revenue	45,090	1,10,702	1,04,813	68,455	1,04,218	28,592	1,60,742
Expenditure	29,991	73,998	78,012	49,902	80,116	26,614	1,43,029
Surplus	15,099	36,704	26,802	18,653	24,102	1,918	17,713
Quantities extracted (mds)	5,619	15,240	14,504	10,571	15,425	4,207	18,377

The above figures do not represent the whole value of the trade as part of the ephedra comes from the Kalat State. The demand is likely to continue after the war.

The twigs are picked by zamindars from the unclassified forests on a biennial rotation (three years would be better) and are brought to licensed traders who sort and clean them and sell them to the Forest Department which meets the demands of drug manufacturers. There is one local factory at Quetta. The method of collection has the advantage of standardising the quality of the raw product.

There are several species of ephedra plants, of which the one now collected is *Ephedra vulgaris*, which contains a high percentage of ephedrine if collected during the winter months, October to March. Other species are said to contain less ephedrine and are not collected. Attention is invited to India Forest Leaflet No. 48 of 1943 and to Indian Ephedras 1931 in Vol. XVI of Indian Forest Records. Samples of all species and varieties will be collected next winter, and sent to Dehra Dun for test.

Goats browse on the ephedra bushes in the winter, and seriously harm them.

Pyrethrum.

Pyrethrum has been cultivated experimentally on irrigated Government land at Quetta as a war measure with great success. The area under cultivation will now be extended to 9 acres, all the Government land that is available. The pyrethrin content is very satisfactory and compares favourably with that produced in Africa and elsewhere in India. The Medical Department requires all that can be produced.

Production in 1944 is expected to be 2,048 lbs. of dried pyrethrum flowers of value Rs. 2,560.

In view of its importance during and after the war it would appear to be worth-while to induce zamindars to grow pyrethrum instead of wheat on a few hundred acres irrigated land near Quetta. 100 lbs. of seed are now available for distribution.

Artemisia.

Santonin is produced from the shrub *Artemisia maritima* variety. rubicolor which has only rarely been found in Baluchistan. Up to date the results have been disappointing, and in view of the lead possessed by Kashmir it is doubtful if a trade in this product could be developed. Seed has been imported from Kurram and there are 1,500 plants in the Quetta nursery.

Chilgoza Nuts.

The seed of the edible pine *Chilgoza (Pinus gerardiana)* is collected and sold in the Zhob district. The forests are small, the trees are overmature and are dying, and the supply cannot meet the demand. Zamindars have rights to collect the seed and no royalty is levied thereon.

Of the above areas 1,479 square miles of the reserves and the whole of the unclassified forests are open to grazing. The statement gives rather a false impression of the extent of the afforested area as some of the reserves are forests only in name and have not been demarcated. For instance the Kaisar reserve covering 220 square miles of the Nushki range contains a considerable area of cultivation, is open to the exercise of undefined rights, and differs in no way from the surrounding waste. The 1,184 square miles of reserves at Nok-kundi were notified in 1940 without demarcating them or settling the rights in any way.

14. The function of the forest.

The forest is a complex association of trees, bushes, shrubs, herbs and grasses, all of which supply material for the needs of man and his domestic animals. In addition, the forest protects the soil and enables it to absorb the rain water: not only is protection given to the soil of the forest, but floods are prevented and cultivated fields are protected. The roots of the trees penetrate far into the soil and the crevices of the rocks and bind them together, assisted by the bushes, and lesser surface vegetation. Branches and leaves prevent the rain in heavy storms from beating down on the surface soil, while the humus formed by the decay of the plants absorbs the rain water and lets it percolate slowly into the soil to emerge later on in the form of springs. Where there is no vegetative covering storm water pours uselessly over the surface of the soil and washes it away; the *nullahs* come down in spate, the rivers overflow, and the water, which should have been absorbed by the forest soil and slowly released, is dissipated, in destructive floods.

It must not be thought that the value of a forest lies in its trees alone; the ground cover is of at least equal importance, and when the latter is destroyed by grazing the trees are not able to hold up the storm water. Nature has so provided that the type of forest produced in conditions undisturbed by the acts of man and his animals is everywhere sufficient to prevent the erosion of the soil.

15. Grazing. The main industry of Baluchistan is grazing. Vast herds of sheep and goats are kept in every village. Cows are not numerous, and are kept only where there is cultivation or alluvial flats where there is grass pasture, as near Gumbaz. There are not enough bullocks to plough more land than is now cultivated. Camels are often used for ploughing as they cost less than bullocks to keep and feed largely on the camel thorn (*Alhagi camelorum*) which is a common weed in the waste. Camels and donkeys are used for transport and graze in the waste; fewer and poorer riding horses are produced than in former years. In addition to local animals there are annual immigrations of large flocks of sheep and goats and herds of camels from Afghanistan, and to British Baluchistan from Marri country. These animals probably do as much or more harm to the pastures than do the local flocks.

That the animals have increased greatly since the British occupation admits of no manner of doubt. There are no reliable enumeration figures, but an indication of the increase during the present century is given from the *tirni*, or grazing taxes, levied. In 1903-4 Rs. 88,682/- were collected; in 1938-39 the figure had increased to Rs. 1,86,797/- and in 1942-43 had dropped to Rs. 1,62,163/-. These figures show a hundred per cent increase in 40 years.

In spite of its importance the grazing industry has received but little attention until recently when a beginning was made with the establishment of experimental sheep farms. No attention whatever has been paid to the proper management of the pastures which are grazed to far beyond their capacity, particularly by nomadic flocks from Afghanistan which pay *tirni* to the Baluchistan Government.

The vegetation of the pastures has every where received a set back owing to the increased numbers of animals which graze thereon, and no longer is there sufficient fodder to support the present numbers of animals. Control must be exercised over the movements of migratory flocks and the limitation of their numbers is essential, and the Afghan Government may have to be consulted in the framing of regulations.

Grazing in the Forest reserves.

I inspected the reserved forests in 1925 and noted that the forests were well protected but that those in which there were no rights were opened to grazing occasionally *when there was famine in the land*. This opening of the forests was justified as this reserve of fodder saved the flocks from starvation, but it was to be used only exceptionally when otherwise mortality would be great. In the ten or fifteen years previous to 1943 there has not been the slightest attempt to conserve the forest grazing but on one excuse or another the animals have been permitted to graze for limited periods each year in the reserved forests, with the sole exceptions of 3 forests near Quetta.

Tirni has been levied for this grazing: sometimes the animals have been admitted by the Forest Officer; often by the Political Agents either with or without consulting the Forest Officer. This is wrong and no closed forest should in future be opened until Government has notified that a fodder famine exists.

The result of grazing has been the destruction of the bushes, herbs and grasses in most reserved forests and this has been followed by the erosion of the surface soil, and the failure of the trees to reproduce themselves. In nearly every juniper forest between the trees is bare stony soil, while each tree shelters a small raised patch of humus and soil on which ephedra bushes maintain a struggle for existence against the ever hungry goat.

16. The effects of the disappearance of the forests. Under natural forest soil accumulates; but when man and his animals have destroyed that forest, Nature takes her revenge; there is no more food for the animals to eat: the soil is carried away in sudden and destructive floods: underground water supplies dry up: fields are swept away and the country becomes uninhabitable. That may appear to be an exaggerated picture of what is happening in Baluchistan: but everywhere the vegetation has suffered severely from the very heavy grazing; the soil is naked and has been washed away from steep slopes; soil erosion is already far advanced; every considerable fall of rain is followed by floods, (the present year has seen the roads breached in all parts of the Province: dams have been broken and fields have been badly damaged). Unless something is done to restore the vegetation and steps are taken to control the grazing by rotation of pastures, by reduction in the flocks to the capacity of the grazing grounds, and by every means that the mind of man can devise, conditions will become worse and the country will not be able to support its present population. A man made desert is a dismal future.

17. Climax types of forest in Baluchistan. Twenty years ago there were thousands of acres of reserved forest which had been closed to grazing and protected for twenty or thirty years, except in years of famine when the forests were opened to grazing in order to save the flocks and herds: but to day (except in 3 forests near Quetta) there is not an acre of forest which has not been grazed over heavily year by year until last year, when the reserves were again closed. Sir Herbert Howard in 1940 was unable to find anywhere the climax type of forest, and the following notes on what it is or should be have been made after careful examination of many thousands of acres of forest throughout Baluchistan.

18. The Juniper Forest. 1. *The climax type.*

Juniper forest formerly covered a large part of the hills from

about 5,500 feet to 10,000 feet elevation, where the average annual rainfall is about 10 inches to possibly 15 inches. The trees were scattered and sent their roots far into the soil, spreading widely in the search of moisture and penetrating the rocks. This sparsely stocked forest is characteristic of semi-arid conditions. Usually the trees were branched to the ground, but in *nullahs* and where the soil was at all moist they grew more densely, and the boles were cleaner. At the higher elevations the trees assumed a stunted and prostrate habit and their branches lay along the surface of the soil.

Between the junipers, except at the higher elevations, were slowly grown ash trees (*Fraxinus xanthoxyloides*), wild almond (*Prunus eburnea*) of bush like form, wild cherry (*Prunus cerasus*), while the ground was covered by a lower story of bushes of (*Caragana gerardiana* and *ambigua*, *Berberis vulgaris*, *Daphne oleoides*, *Ephedra vulgaris*, *Spirea kabulica*, *lonisera*, and *buddleia* together with *Artemisia brevifolia* and *maritima*, and spiny *acantholimon* and *astragalus* perennial plants, thin *khavi* (*Cymbopogon jawarancusa*) and other grasses, eremurus lilies, tulips, and herbs of numerous cruciferous, leguminous and composite species. As with the trees, so with the bushes, herbs and grasses; the plants were of isolated habit owing to the difficulty with which they were able to obtain sufficient moisture for their growth.

The juniper was long lived, occasionally to over 500 years to age, with the result that the old trees persisted and occupied far more space than was their due share. Seed was produced copiously and germinated, but the seedlings persisted only where conditions were particularly favourable for example where the shade of some bush protected the young plant from the intense heat of the sun.

Underneath the old trees, and held up by the support which they afforded, soil and humus accumulated and the ephedra plant found suitable conditions for growth. The soil in the spaces between the juniper trees was held in place by the bushes, herbs and grasses.

ii. *The present forest reserves.*

To-day many old juniper trees survive, half dead and dying: but their end is not yet, as they take an unconscionable time in dying. Under their shade is still, usually, some earth, but between them the soil is bare and thin, and only sparsely covered with bushes and herbage. Often the soil is stony, unshaded, hot and dry and on it only xerophytes such as thyme and *Morina persica* grow. The soil is unable to support the more moisture loving plants and no longer does the forest produce in profusion the aromatic herbs and shrubs for which Baluchistan was formerly justly famous.

Where the forests are open to grazing the numbers of animal admitted have not been limited to those recorded as possessing grazing rights. Many of the forests which are open to the exercise of rights are in no better condition than the *guzaras* described below.

iii. *The guzara forests.*

Outside the demarcated forests the sole control exercised is over the felling and lopping of juniper trees, but that is only partially effective. Lopping is nominally controlled but the trees are lopped for fencing, rafters and fuel. The forests are all heavily over-grazed the soil has vanished from the bare sheet rock, the roots of old juniper trees are exposed and everywhere there has been severe erosion of the surface soil. Some *spirea* and other plants persist in the cracks and crevices of the rocks and a few spiny xerophytic shrubs and grasses manage to survive. Where the soil is deeper as to the north west of Ziarat, it is badly eroded. It is too late to perpetuate the old type of juniper forest as the soil, where it still persists, is too sterile, but protection from

grazing would result in some juniper regeneration and in the covering of the ground with herbs, grasses and bushes. Demarcation should be extended to the whole of the *gutaras* where juniper is found, and grazing should be regulated as described later on.

19. The olive forest. (i) *The climax type.*

No natural climax type of olive forest was seen. Even before the British occupation, the forests were heavily grazed and the olive trees were pollarded and leaves and branches being a favourite food of the sheep and goat and indeed of all browsing animals were lopped. I found no seedlings, but very occasionally saw young olive saplings amongst dense masses of dwarf palms.

(ii) *The present forests.*

Olive trees persist from about 4,000 to 6,500 feet, or higher. The olive trees are old, mutilated and are generally mixed with *Pistacia kharjak* or *mutica* trees, most of them old, and only very occasionally are there a few young pistachio plants. There are a few *Daphne oleoides* bushes, but the main ground cover is grass, which grows in tufts separated one from another by bare earth. The dominant species are *Chrysopogon javarancusa* and *Eulaliopsis binata*, the *bhabbar* grass, which outside Baluchistan is used for ropes and paper manufacture. The soil is far too dry for olive seedlings to grow.

The Tomagh reserve forest was coppiced from 1937 onwards for the firewood supply of Loralai and Quetta, but after felling it was opened to grazing although there are no rights. The olive has still persisted, such is its recuperative power, but only as much browsed bushes. In no country in the world where forestry is practised is browsing of young coppice shoots permitted and the late Forest Officer should never have allowed it.

At lower elevations the olive is mixed with *phulai* (*Acacia modesta*) trees, which generally are of poor growth, but which are remarkably persistent and manage to regenerate occasionally under the most adverse circumstances.

In the Attock district, in mixed olive and *phulai* forests where grazing is not permitted, olive seedlings are found under the *phulai* trees and *sanatta* (*Dodonea viscosa*) bushes and in this manner the olive is perpetuated. But in no forest in Baluchistan that I have seen is there any olive regeneration whatever.

At the lowest elevations of all, from about 3,000 to 4,000 feet there are *phulai* and some dwarf *Tecoma undulata* *Zizyphus oxyphylla* trees with *Periploca aphylla* and *Zizyphus nummularia* and *ephedra* bushes, with spiny *acantholimon* bushes *Sophora griffithii* shrubs while in steep sided deep drainage channels in the limestone rocks are numerous old olive trees which still exist in spite of the heavy grazing. Outside the reserves the forests no longer protect the soil and erosion is very bad indeed.

20. The karil and bata forest. From about 3,500 feet downwards the country is very dry and the natural vegetation consists of xerophytes such as *karil* (*Capparis aphylla*) *Zizyphus oxyphylla* and *nummularia*, spiny repellent bushes *Salsolaceous* plants, thin grasses and minute herbs.

21. The upland valleys. There has been much sheet erosion. The upland valleys and the neighbouring slopes at about 4,000 to 6,000 feet are covered with *Artemisia brevifolia* and *maritima* bushes, spiny *Acantholimon*, and *Astragalus* bushes, *Sophora griffithii* and dry type grasses.

Lower down *haloxylon*, *salsola*, and other desert plants cover vast stretches of arid flats.

22. The Tamarisk forest. Sheet erosion is common. In the *nullah* beds are *Tamarisk annulatum* trees and *Tamarisk dioica* bushes which appear on naked silt. These occupy the flood plains of the Narechi river, forming groups of bushes which obstruct the passage of flood water and cause it to drop its load of silt. Between these groups the open spaces are covered with *khabbal* (*Cynodon dactylon*) and *palwan* (*Dicanthium annulatum*) grasses, excellent fodder for cattle, and sedges, all of which induce the deposit of silt and raise the level of the plain. Outside the Gumbaz grass reserve grazing of *powinda* flocks and herds is so heavy that the tamarisk clumps are prevented from spreading and the grass is poor. There are some mature *Populus euphratica* trees but no young seedlings as they are eaten. In the Kaiser reserved forest, which is open to grazing through out the year except in the small tamarisk forest which occupies the *nullah* bed, there are densely stocked tamarisk saplings and coppice shoots. Elsewhere the tamarisk is so browsed as to be almost invisible.

23. The stony, torrent bed. Within the hills tamarisk bushes maintain a footing on the stony torrent beds in spite of the heavy grazing, but they are rarely permitted to grow to any size. Oleander bushes grow as they are poisonous to animals. There is much *Saccharum ciliare* grass (a small cousin of *S. munja* of the plains); some *S. spontaneum* var. grass, and in places, as at Wam Tangi the bush *Vitex negundo* flourishes. At Wam Tangi the *shisham* (*Dalbergia sissoo*) occasionally grows to fine dimensions probably because its roots tap the underground waters. The dwarf palm (*Nannorrhops ritchiana*) grows on the sides of the valley at from 3,000 to 5,500 and in the torrent beds.

Where the torrents debouch into the upland plains, and where grazing is heavy *Withania coagulans* and *Rhazya stricta* persist with some *Sophora griffithii* bushes, some of the species mentioned above and a few scattered grasses. If protected from grazing more abundant flora would flourish, which would check the violence of the floods.

Of the above plants *Dalbergia sissoo*, *Vitex negundo*, *Saccharum munja* var. *ciliare* and *spontaneum* var are most useful species for afforesting torrent beds.

24. Cultivated trees. Where there is water trees can be cultivated, and sometime the irrigation channels are bordered by mulberry, willow and poplar trees. At stations such as Quetta and Fort Sandeman the number and variety of the trees are considerable. The natural conditions would favour the growth of trees along all artificial and natural water channels were it not for browsing by destructive animals.

25. General. Enough has been written to show that throughout Baluchistan the natural, undisturbed vegetation was formerly much more abundant, and consisted of more diverse and higher types of plants which survive now where they have been protected, or, like the juniper and olive, have a length of life far greater than the human span.

Before the British occupation the villages were small collections of huts or mud houses near small patches of cultivation, which the people defended from their enemies as best they could. Most of the people were shepherds who moved their simple tents or built fresh temporary shelters as they exhausted the pastures, or when at the natural change of seasons there was a fresh flush of vegetation at higher or lower altitudes. Immigrant shepherds had to placate the tribesmen, or to fight for a footing in the country. There were no large towns whatever, and the people, limited in numbers as were their domestic animals, were not more than the country could support.

The British occupation has, in spite of occasional set backs, brought peace and prosperity to a troubled land, and, although the population has not increased, flocks of sheep and goats have multiplied many fold, and more and larger migratory flocks traverse the valleys enroute to and from the plains or remain to graze with Government's permission.

Cantonments, together with their accompaniment of camp followers, have been established in various localities, and these centres of population are new factors which are not indigenous to the country. They have made demands for fuel, both of trees and of bushes which are dug out by the roots, for meat and milk, with the result that the forests in their neighbourhood have been denuded.

26. *Cultivation.* Throughout Baluchistan the rainfall is low and varies from year to year but increases with elevation upto 10 or more inches. The principal cereal crops are wheat, maize, and millets, the last being grown as much for fodder as for grain. Most of the rain falls from mid-December to March and in July: but occasionally there are severe thunderstorms, especially in April and May, when much rainfalls in a very short time and does more harm than good as the floods break the embankments. Land is plentiful, water for irrigation is short, and it is customary to cultivate the land for one year and to let it lie fallow for three years or less, in order to restore its fertility. No fields at a distance from the homestead are ever manured.

In many parts of Baluchistan, particularly in the Barkhan tahsil, less in the Quetta-Pishin district, the standard of arable cultivation is very high indeed, and the local cultivator has nothing to fear in comparison with the rest of India: Water is conserved to the best advantage, and if a little more attention were paid to drainage and to the prevention of damage by rats to the embankments there would be no avoidable soil erosion. The shortage of man power makes it difficult to do more than is done at present.

The following methods of cultivation may be distinguished in the upland tracts with which alone this note is concerned. Classes (i) and (ii) contain fine fruit orchards.

(i) *Perennial irrigation from springs and streams.*

Fair crops are produced where water is available for irrigation. Where the fields are terraced, are level and are bordered by peripheral embankments, they are permanent and are cultivated for wheat, maize and millets, and garden crops and occasionally, for example near Harnai, for rice. Where fields are cultivated without proper levelling there is much soil erosion as in the neighbourhood of Quetta. The practice of following for long periods leads to the neglect of the bunds, which are undermined by rats and near the edges of the plateaux both sheet and ravine erosion are severe and ravines are extending, particularly in the Quetta-Pishin district.

(ii) *Perennial irrigation from a karez, or underground water channel driven into a talus at the foot of a hill.*

The fields are cultivated and followed in rotation. The extent of land available is greater than that for which there is karez water and advantage is taken of favourable rains to extend the area cropped. Where the fields are level and embanked they are permanent, but in years of heavy rainfall the bunds are broken by storm water as there are no weirs to regulate the escape of flood water. Erosion is taking place in a manner similar to that described at the end of the previous paragraph.

(iii). *Inundation from the rivers.*

In July and August and whenever the rivers are in flood their water are utilised to inundate the fields. Good examples were seen in the flood plains of the Narechi and Anambar rivers, where there is room for expansion of cultivation but labour is scarce. Every drop of water of the Kaiser river is also utilised for inundating the fields.

Inundation from torrents when in flood.

The beds of the torrents which issue from the hills are dry for the greater part of the year, but when rain falls there are sudden spates or floods which raise and fall with great rapidity.

- (a) In broad valleys of the hills the stream is canalised by embankments and spurs, and on one or on both banks stone walls or earthen bunds are built along the contours. The silt-laden flood water is diverted and held up by those walls and silt is deposited, until after a few years deep of deposits of silt are formed in terraced fields of great fertility.

When the *nullah* is in flood the storm water is led to these fields and the soil is moistened and in due course is sown with cereals.

- (b) At the foot of the hills the flood waters of the torrents are diverted by means of stone and brushwood spurs and by stone or earthen dams to elaborately terraced, level fields, on which the waters are ponded up behind very substantial horizontal peripheral earthen bunds, or *latts*. There are most elaborate customary local regulations for the use of this water. The differences in level between the fields are frequently very considerable, bunds or *latts* of eight or ten feet in height being by no mean uncommon in the Barkhan tehsil. Rats do much damage as they burrow in the bunds which are liable to be breached by the water which pours down in a devastating flood. Proper stone weirs are required to regulate the inflow and the outflow of the water to and from the fields but the villagers say that they cannot afford them.

These methods of utilising flood water are excellent and are as well developed as can be expected with purely local resources. Irrigation officers might be able to improve on them by building proper regulators and escape weirs at Government expense at selected centres as demonstrations of correct methods; they might study the behaviour of the torrents, as the violence and frequency of the floods have increased by reason of erosion of the catchment areas, and the villagers are finding it more and more difficult to deal with the floods. Bunds are frequently broken and fields lie derelict after their surface has been eroded by flood water.

(v). *Fields formed by blocking valleys with earthen dams.*

Near Barkhan a valley has been blocked by two huge privately constructed dams and a third is in course of construction. Some idea of the magnitude of the effort is given by the dimensions of the middle dam which is roughly 900 feet in length, 20 feet in height with a substantial broad base. The dams are formed of closely packed earth with escapes cut through the rock on one side, in which are regulators by means of which the height of the water can be controlled. The object is to pond up the water behind the dam in order that it shall deposit silt which will get deeper from year to year and will be moistened by flood water.

On the night of 6th/7th June 1944 one and half inches of rain fell in three quarters of an hour, storm water poured down the *nullahs* and burst the dams for the reason that the escapes were too narrow and the regulators were closed.

What was apparently the cement foundation of an ancient dam were seen, which had probably been destroyed in former floods, but of which there is no memory.

The catchment area is bare and is grazed heavily every year which means that the water runs off the surface very rapidly and that the violence of the floods is greatly increased. Closure to grazing would certainly help to reduce the violence of the floods, but would be resisted by *powindas*.

(vi) *Dry cultivation in embanked fields called Khushkaba.*

- (a) In regions of low but adequate rainfall the fields are terraced, levelled and surrounded by an earthen embankment, locally called a *latt*, by means of which the rainwater is constrained to soak into the soil of the field on which it falls. By these means the whole of the rainwater is conserved and the crops produced are far better than those on unlevel ground.
- (b) Where the fields lie below the hills advantage is taken of the rainwater which falls on the slopes above the fields to increase the amount of water for the crops. The fields are levelled and embanked as before; along the slopes channels are built by means of which storm water is conducted to the fields. This enables crops of wheat to be grown in regions where the annual rainfall is as low as 5" as in Chagai district. This latter method is half way between *Sailaba*, or inundation cultivation, and true *khushkaba*, or dry cultivation, on which it is an improvement.

Cultivation is precarious and except in favourable years, does not extend over more than one quarter to one third of the arable area available.

Rats do much damage to the *latts*, while in storms the embankment are broken by reason of the failure to provide proper stone escapes by means of which the amount of water admitted to the fields can be regulated and limited to the volume which the *latts* can support.

The process of levelling.

Fields are levelled mainly by the use of the *khal*, or bullock drawn earth scoop. Levelling is not completed at one time; the *latts* are built first in order to pond up the rain water, the soil is ploughed and the rainwater is allowed to bring down the loose earth to help in the process of levelling. Catch crops are sown in order that the ground shall be utilised during the process of levelling which takes a few years where the slopes are at all steep.

(vii) *Dry cultivation without embankments in the Pishin district, also called khushkaba.*

The flat plains near Pishin are cultivated by tenants-at-will without making any attempt to conserve rainwater. The soil is a light loam with varying proportions of sand and clay. After rain has fallen the land is ploughed once, sown broadcast with wheat and harrowed. Very thin crops of wheat are produced which are full of weeds (camel thorn). The tenants do all the work, and take 5/6ths of the drop, the landlord spends nothing on improvements and takes 1/6th of the produce. The low hills beyond Kila Abdulla, and near Inayat Ullah and Gulistan are cultivated in a similar manner and the crops this year are very poor indeed. The basic reason for this slack method of cultivation without embankments is the lack by tenants-at-will of any permanent lien on the land as the land is allotted to them for one season only, and there is no certainty that they will be able to cultivate the same fields in the next year. Consequently the tenants make no attempt

to improve the land; they plough it once only, and as there is no shortage of land they plough as much as they are able, which is not considerable as they are short of plough bullocks and use camels and donkeys instead, as these animals are easier to feed. Should they be lucky and should rain fall in time and in sufficient amount the crops are good: but should rain be delayed or should drought be long continued, as often happens, the yield of wheat is exceedingly low. Cultivation of this nature is a gamble in rain.

Soil erosion in Pishin district.

Erosion in the hills is serious and this is due here as elsewhere, to the destruction of the vegetation by over grazing.

There is much sheet and ravine erosion in the plateaux. As a rule, irrigated lands are stable: but the practice of fallowing for several years results in the fallow fields being neglected. Rats burrow in the bunds and weaken them, with the result that when rain falls the water escapes and flows into ravines which are extending.

Where the surface of the *khushkaba* field is sloping and there are no bunds sheet erosion of the top-soil is severe; plateaux near the main lines of drainage are ravined and extending.

Erosion follows on slack and faulty methods of cultivation, and these are due very largely to the unsatisfactory uneconomic relations between landlords and tenants. Recently in the Punjab an act (Act IV of 1944) has been passed by which Government has the power of compelling the owner, or, where there are occupancy tenants, the tenants to put their lands in order. Should they fail to do so Government may do it for them and recover the cost up to a value of ten times the land revenue of all lands possessed or cultivated by them. This may result improved cultivation: otherwise it may be necessary to revise the tenancy laws.

Use of tractors for khushkaba cultivation.

There is a shortage of labour as the local inhabitant prefers the life of a shepherd to that of an industrious arable farmer. There is a shortage of plough bullocks which are difficult to feed as there is little grass and *dhusa* is expensive, with the result that in many places donkeys and camels are used to plough the fields, particularly the latter as they browse on the camel thorn weed and salsolaceous plants in the waste. It has therefore been suggested that upland valleys should be ploughed by means of tractors.

From what has been written it will be seen that the conservation of water by means of terracing, levelling and embanking is an essential preliminary to arable cultivation. Accurate levelling and the building of peripheral embankments along the lower edges of each terraced field would be essential. This presumably would be done by graders or "bulldozers" such as are used to level aerodromes. Water from the hillsides would be led on to the fields where practicable in order to moisten the soil sufficiently for the growth of wheat. I do not think that it would be worth while to plough the fields by tractors without *latibundi*: it might succeed if rains were particularly favourable but the odds are against it, and should the rain fail the crops would fail also. As the fields would necessarily be large in order to permit of the economical use of machinery proper drainage would be needed.

In the Punjab the moisture in the soil under dry cultivation is conserved by frequent shallow ploughing whenever rain falls, up to twelve times or more in the course of the year; in Baluchistan this is not customary and the fields are ploughed far less frequently, but the greater the number of ploughings the greater would be the yield of wheat.

Tractor cultivation is not a simple solution in itself but must be accompanied by levelling and embanking, by adequate drainage and by good and proper tillage, otherwise the crops would be poor and the yield so small as not to repay the costs of cultivation.

27. Road drains and spurs Along and above the roads hundreds of miles of contour drains and diversion channels have been built many years ago in order to prevent stones and silt being spread over the roads. Some are useful but the majority have not proved their worth, but they show that the menace of soil erosion has been appreciated by road engineers for many years past.

Many stone embankments and spurs, often bound with hercules wire netting, have been built to prevent the floods from breaching the roads and railways, but in spite of all precautions floods do much damage annually and in 1944 communications were badly interrupted. The total cost of protective works must have been very great. In my opinion the threat to communications is increasing by reason of the disappearance of vegetation which is now insufficient to check the flow of water over the surface of the ground.

SUMMARY.

28. Soil erosion. After a most careful study of conditions in representative sections of each district I have come to the following conclusions:—

(i) *The extent of soil erosion.*

A. Erosion due to water action. Throughout the hills there has been very severe erosion of the soil. Where the underlying rock consists of limestone, or other hard rocks the soil has disappeared: where there are shales or soft earth gullies have formed.

Along the main migratory routes the soil is naked and is eroding with extreme rapidity, for instance in the Dilkuna-gorge.

The torrents come down in dangerous spates and debouch with great violence on to the upland plains, in which they fan out and wash away the surface soil. The violence of the floods makes it difficult to build and maintain inundation dams and channels and the fields are threatened. The threat to road and rail communications is increasing.

In the gently undulating upland valleys surface erosion is universal.

Near the main lines of drainage the edges of the plateaux are fretted with ravines which extend far into the cultivated lands of the Quetta-Pishin district and are increasing. In other districts ravines are present, for instance near Loralai, but they are not so severe for the reason that these districts are less heavily cultivated.

Where the fields have been levelled, embanked and intensively cultivated soil erosion has been reduced to a minimum.

Where slopes have been ploughed without terracing or embanking sheet erosion is severe and ravines are extending rapidly. Where irrigated fields are either inadequately levelled, as near Quetta, or allowed to lie fallow for one, two or three years as is common everywhere erosion of the fields near the ravines is severe and the ravines are extending.

B. Wind erosion. In the chapter on the Ohagai district wind erosion has been mentioned, and the function of the vegetation in preventing the drift of sand, particularly that of the *taghas* tree (*Haloxylon ammodendron*) has been described. At Mastung sand dunes are drifting across the road, driven on by the north west wind. Houses, fields, orchards and one irrigation channel have been overwhelmed and buried under sand; villages have been wholly or partially abandoned and more are threatened; grave yards have been covered with sand. A closer examination of the sand dunes shows that scattered plants are endeavouring to obtain a footing and spread in the sand dunes, and undoubtedly they would do so eventually and they would succeed in holding the sand in place were it not for the voracious animals sheep, goats and camels, which browse in the sand dunes. Among the most common species were *Sophora griffithi*, *Salsola* sp., *haloxylon* sp., *othonnopsis intermedia* which is not eaten and is regenerating, *euphorbia* spp., *harmal*, a couch grass (*Cyanodon*?) *heliotropium Richwaldi* and other plants which were not identified.

The herbs and grasses are doing their best, and if left alone, would fix the sand, but man's domestic animals devour them and ensure that the sand dunes shall march steadily forwards until they are arrested by the barrier which the hills oppose to their further progress.

(ii) *The causes of soil erosion.*

The main cause of soil erosion is excessive and unregulated grazing. Faulty methods of cultivation are the cause of much soil erosion in the Quetta-Pishin district, and sometimes elsewhere, as long the Mastung road.

(iii) *The cure for soil erosion.*

The proper management of the pastures; the limitation of flocks to the numbers which the vegetations can support; and closure to grazing in rotation are the cures for avoidable soil erosion in the greater part of Baluchistan. The elimination of faulty methods of cultivation would prevent soil erosion in cultivated lands.

29. *Policy.* It is not easy now to set back the clock. Any attempt to do so must necessarily mean a complete overhaul of policy in relation to rural economy with a view to the improvement of the vegetation and the prevention of soil erosion throughout Baluchistan, rather than the nominal protection of a small area of reserve forest and half hearted attempt at the preservation of trees of a few reserved species in the village waste.

There are three choices before Government :—

- (a) To carry on as at present.
- (b) To reorganise the Forest Department so as to manage the present forest estate, and to extend it moderately.
- (c) To preserve vegetation throughout Baluchistan and so to regulate its use that it shall be a permanent economic asset to the Province and shall prevent as far as is possible soil erosion and floods. To conserve water and utilise it to the best advantage. To conserve the soil of the cultivated fields by the avoidance of faulty methods of cultivation.
 - (a) Is out of the question and will not be considered.
 - (b) Is a temporary expedient for which I shall submit proposals for the necessary increases in staff.
 - (c) Is the sole policy that I am able to recommend to Government.

30. *A planned Rural economy.* The forests, pastures and arable fields all form parts of one estate, which must be managed properly in the public interest. The policy will aim at the protection and increase of vegetation throughout Baluchistan: its proper and regulated use in order to provide a permanent yield of vegetable and animal products, for example medicinal herbs, timber firewood, sheep, goats, cattle, riding and transport animals: the conservation of the soil of the "waste" the prevention of floods: the conservation of the soil of the fields: the conservation of water: the extension of arable cultivation in the upland plains. This may be summed up as the use and not the abuse of natural resources. Plans will provide for the management of the estate as a whole, in order that man and his domestic animals may live in harmony with their environment.

31. *The means of giving effect to the policy outlined in subpara (c)* It is easy to suggest remedies: it is far from easy to put them into effect without upsetting the political, social and economic life of the country, and yet a change to proper management of the whole estate must be made now unless the natural resources of the country are to dwindle to vanishing point. The first task is to persuade the local people themselves of the need for conserving the vegetation; the second is to design and put the necessary measures into force: the third is to regulate the use of the pastures by migrants from outside.

Propaganda.

Propaganda and demonstration of the effects of rotational closures are required. For this it will be necessary to start in a small way by the appointment of a keen and enthusiastic officer for soil conservation, preferably a local man, or one from the Punjab of skill, experience, capacity and, particularly, tact. He must possess the confidence of Government, must have faith in his mission, and should be able to talk to the people in their own language. This is discussed at length later on.

A—THE FORESTS.

32. Suggestions for technical management. Complete closure to grazing and browsing, and the use of the forest according to a sanctioned plan, which shall provide for a permanent yield of forest products, is the absolute cure for erosion. That is practicable only in a country where there is a demand for cut grass for stall-feeding, but in Baluchistan the demand for cut grass is confined to the cantonments, and the local inhabitants want not grass but grazing. A form of periodic, rotational closures is all that can be adopted. The methods of management would vary according to the conditions of each local area, and the demands for forest products. The detailed management of each area would be prescribed in properly sanctioned working plans, and the following suggestions are made for the guidance of the soil conservation officer and of working plan officers.

I. The Juniper forests. The whole of the juniper forests should be demarcated and notified. Rights of user should be recorded. One-quarter of each catchment area should be closed permanently to grazing. This would provide for the proper conservation and use of timber, fuel, ephedra and medicinal herbs, and would protect the upper parts of the catchment area from erosion. The remainder would be divided into 3 portions, one of which would always be closed to grazing, in order that the vegetation could recover. Closure would probably be required for 30 years in the first instance as the forests are extremely eroded; but this could be shortened or lengthened subsequently should experience prove it to be necessary.

In the closed portions regeneration operations would eventually be undertaken artificially, should no natural regeneration appear: but the soil at present is so unfertile that time must be given for it to recover by the natural increase in the ground cover before money is spent on planting.

II. The olive forests. The whole of the areas capable of being maintained as forest should be demarcated and rights should be recorded. Two methods of management are practicable according to whether it be decided to manage them for grazing alone or for fuel and grazing combined.

For grazing alone.

One quarter, preferably the upper portion of each catchment area should be closed permanently. The remainder should be divided into 3 portions, each of which should be closed to grazing in rotation. The villagers should be consulted as to the length of the closure period which should be in the interests of the grass.

The trees should be pollarded in order to provide fodder; a short cutting cycle would give only leaf fodder, a longer rotation would give axe and tool handles as well and might be in the interest of the villagers.

Dead trees alone should be felled.

For fuel and grazing combined.

If it be decided that the demands for fuel for the cities and cantonments

be paramount then regular coppice fellings should be introduced. The rotation should be 40 or 60 years and each compartment felled over should be closed absolutely to grazing for 10 or 15 years after felling. Compartment boundaries should be laid out on the ground and on the maps.

iii. The *Phulai* forests. Where the proportion of olive is considerable the working of the mixed *phulai* forests should conform to that of the olive forests. Where the forests consists of only scattered *phulai* trees they should be managed as pastures.

iv. The Tamarisk forests and the ravine beds. With closure there would be a great increase in the growth of tamarisk and other species. A coppice rotation of 20 years with closure for 5 years after felling would help greatly in the local fuel supply. Later on when the violence of the floods has somewhat abated, owing to the effect of closures in the hills, it should be possible to afforest, after closure to grazing, large portions of the torrent beds with the help of *sargassi* grass, *Vitex negundo* bushes and *shisham* stumps, utilising the flood waters to inundate the plantations, without any other cost on irrigation, the methods employed being based on torrent bed reclamation as practised in the Punjab. A start might be made now with the undemarcated forest below Wam Tangi reserve where already there is much *Vitex negundo* scrub forest.

B—THE PASTURES.

33. The low scrub forests and the pastures. Little is known of the proper treatment of pastures and of the proper management of flocks. Factors of cardinal importance are the proper rotation of the grazing grounds and closure for the restoration of the vegetation, and the limitation of flocks to the numbers which that vegetation can support. In this matter the advice of the animal husbandry expert is needed. The areas should be notified as protected forests and the rights defined. For the present it would be sufficient to enter them in the *wajib-ul-ars* at the Land Revenue Settlement. In the better pastures rapid rotation of the grazing grounds combined with closure while the grass is growing might be sufficient. It must be remembered that minute cruciferous and other herbs which appear in the spring, afford excellent grazing, and their proper use must not be neglected if the land is to support the maximum numbers of which it is capable.

The villagers should be freely consulted, the point being that some form of proper pasture management must be devised, in order to conserve the pastures in the interests of the people and to stop erosion of the soil. That the people realise the need for closure is shown by the occasional practice of *pargor*, or the closure until early November of special areas in the neighbourhood of villages.

34. Grazing by migratory flocks. The damage done by migratory flocks on their annual migrations is very serious along the main routes, for instance in the Dilkuna gorge. Tribes migrate from Afghanistan, Marri and elsewhere with their flocks and herds, grazing in recognised pastures, but without definite rights and for indefinite periods. They pay taxes to Government or to local Maliks, or to both, but otherwise their movements are uncontrolled and the numbers permitted to graze is unlimited. The subject is too wide and the movements are too complicated to be described in a short review of this nature, and a report on grazing customs could be made by local officers, if so desired. In no case should migratory flocks be permitted to graze in the closed areas, or to graze in such numbers that they ruin the open pastures. Their movements require regulation and far more attention than they have received in the past.

35. Jirga forest and pastures. The need for proper pasture and forest management in the interests of soil conservation far outweigh the revenues received therefrom. It is not likely that a constructive forest and pasture policy would be welcomed by the people unless they derive a direct benefit therefrom, and if

suggest that they may be encouraged by Government's making over the revenue, including *simi*, derived from the forests and pastures to the people where they agree to management according to a working plan drawn up on the lines suggested above and sanctioned by Government. The forests of each tribe would be managed according to the working plan by a forest officer (a forester or forest guard) appointed by the Jirga with Government's previous approval. The forests and pastures would be inspected regularly by the Forest Officer or his assistant and, if management were satisfactory, the revenues derived therefrom would be handed over to the Jirga for distribution to the villagers.

The cost of demarcation would be paid by Government, and, where the revenues were inadequate, the cost of the village forest officer would also be borne by Government.

The scheme for Jirga Forest and Pasture Management would, in its essentials, be comparable with that which is proving to be very successful in the Kangra district of the Punjab, which is fully described in the Survey of Soil Conservation in the Punjab which is now with the press for printing.

C. CULTIVATION.

In many parts of Baluchistan the cultivation of the land is all that can be desired. Adequate levelling, terracing and embankment of the fields conserve the water and preserve the soil. Faulty methods of cultivation which are very common in the Quetta-Pishin district must be eliminated, and to begin with propaganda is required. Power to insist on proper cultivation should be taken by means of legislation similar to that recently enacted in the Punjab.

26. Present action required. The first thing to be done is for Government to decide on and to announce its policy. The next is to appoint a Soil Conservation Officer who shall study in detail the problem of soil conservation in Baluchistan, and shall then by means of propaganda induce selected tribes to accept the Jirga Forest Scheme. Should the scheme prove to be impracticable he should devise other means and submit other proposals to put a stop to soil erosion in Baluchistan.

It is desirable that this officer should be either an Imperial or a Class I Forest Officer, and that he should be seconded to the Political Department in order to give him the necessary influence with the people. He will have a difficult job and will succeed only when he has the strongest support of the Administration, of the Political Agents and of the *Tahsil* staff.

He will need subordinate staff, which will require training; and arrangements may be made with the Punjab Government to train two foresters a year for the next 5 years at the Punjab Forest School.

37. Future development. The future of soil conservation in Baluchistan will depend on the success of the officer in inducing the people to accept his schemes: also on the vigour with which Government decide to carry out a policy of soil conservation in the event of opposition by the people in its early stages.

As already noted the small population and its sporadic distribution over a wide area make administration expensive and difficult. It will first be necessary to instruct the Political Agents to give effect to the practical means, mainly closures, suggested in previous paragraphs on technical management, and they would be guided and advised by the Soil Conservation Officer. Further development would depend on the success of the above efforts to conserve the soil. Ultimately, should the work justify further expansion, there should be a technically trained and efficient gazetted soil conservation officer in each district, working as Assistant to the Political Agent but under the technical guidance and

administrative control of a Conservator of Forests, or a Director, responsible to Government through the Revenue Commissioner. That would certainly be better than an entirely separate soil conservation department. The necessary subordinate staff would be trained at Dehra Dun and at the Punjab Forest School.

The service would absorb the present Forest Department Staff and would manage the present forest reserves in the interests of soil conservation.

38. Immediate improvements required in the present Forest Department organisation. The change to management by a Forest Ranger was made in 1923, and was to have been accompanied by inspection by a Punjab Forest Officer of Administrative rank at two years intervals. There has been no inspection since 1925 by any Forest Officer, other than the Inspector General of Forests in 1940. The Forest Rangers were left too much alone, they had no previous experience of managing a large and difficult charge, and for some years previous to 1943 were unable, to withstand the demands of the people for extra grazing, particularly when the latter were backed up by Political Agents who did not understand the need for forest conservancy. This is no reflection on the present Forest Officer who has done well in a difficult charge. Work has greatly expanded during the last 10 years, owing to the extraction of ephedra, pencil cedar slats and firewood, and the cultivation of pyrethrum.

39. (i) The Chief Forest Officer. As suggested by the Inspector General of Forests it is essential to obtain the services of an Imperial, or Class I, Forest Officer, but if that be not possible immediately then annual inspections by a Conservator from the Punjab, North West Frontier Province or Sind may be arranged. This post of advisor would not be a sinecure, and should be paid for. It is unlikely that the Punjab or North West Frontier Province could spare a Conservator for this work during the war, but Sind might be able to do so. As will be seen later I consider that the subordinate staff is incapable of carrying out its duties. To replace it immediately is impossible: to discharge it wholesale would throw the forest administration out of gear. Improvement must be gradual and the advice annually of an experienced outside conservator would be invaluable to the Baluchistan Government. I would suggest that in any case the lowest pay of the post of Forest Officer should be Rs. 400/- as it is quite wrong to employ a low paid officer on work involving so much responsibility.

(ii) The Executive subordinate staff. The present staff is untrained and with some exceptions is inefficient. It is largely illiterate but possesses important qualifications: the men are of robust constitution, know the forests well, can identify every herb and plant and know its local use. One Forest Ranger trained at Dehra Dun has less than 2 years service. A statement of the present staff and what is required is given in the appendix, I.

40. Appointments to grade. Forester and upwards. The difficulty is that there is no means of obtaining trained forest subordinate staff during the war, and the replacement of the present staff by trained men must be gradual. It is very difficult to obtain local villagers with any educational qualifications but it is quite useless to take city bred youths and to expect them to make useful forest subordinates, as unless a lad has a rural background he longs for city amenities and dislikes a forest life. For all outdoor posts of foresters and upwards Government should endeavour to select only country boys of sufficient education to be able to follow the Dehra Dun Forest Rangers courses in English or the Punjab Forest School courses in Urdu. This applies equally to men recruited from Baluchistan and from outside.

41. Appointments of forest guards. In tribal areas local men are appointed as forest guards on the recommendation of the local Malik and Political Agent. They rarely have any work other than protection and they have a particularly easy time. At Shinghar there are one forester and 6 forest guards, but until the past winter no seedling was ever planted, no forests were ever closed and I could not ascertain what work the men were supposed to do. Their salaries

represent sometimes subsidies to local villages, the payment of which serves to prevent undue abuse of the forests. A more useful role for them may be found in the suggested Jirga Forest and pasture scheme.

42. Travelling allowance. Fixed monthly allowances for travelling do not encourage subordinates to tour. All should be on a daily basis. Foresters, Deputy Rangers and Rangers should be expected to tour normally for 20 days in the month.

43. Office staff. The office was inspected and a separate report has been submitted to the Revenue Commissioner, together with a duplicate report for the information of the Accountant General, whose attention may kindly be invited to certain matters of accountancy, which require his attention.

Generally speaking the office is efficient but the old records require sorting and weeding.

The staff requires minor additions owing to the present extent of miscellaneous departmental operations for extracting sphedra, firewood etc., which must continue during the war. When these operations cease the staff should be reduced in consultation with the Conservator. An annual inspection of the office by the Conservator is desirable.

44. The firewood supply. Great endeavours are being made to supply firewood from the hills to Quetta, Loralai and Fort Sandeman.

In 1925 I noted that the supply of dry firewood near Quetta had been exhausted. For Fort Sandeman green trees have been cut by the villagers against orders and allowed by them to dry before being brought to depot in order to get over the rule against cutting and selling green wood.

In 1925 I suggested the formation of an irrigated plantation of 8,000 acres but the whole of the new colony land is now under food crops.

There is no solution to the firewood problem other than the creation of an irrigated plantation in the plains, unless arrangements can be made with the Sind Government to earmark part of their outturn for Quetta. For many years past Artemisia, Sophora and other shrubs have been dug out by the roots for use in *tundur* ovens and for use by the poorer classes in Quetta, which hastens the erosion of the soil.

It is understood that there are undeveloped seams of coal which might be exploited, when it would be possible to conserve firewood and use it for kindling only.

Irrigated Fuel plantation. As suggested in 1925 an irrigated plantation of 8,000 acres is needed to supply Quetta with firewood. Shisham trees are grown on a 20 years rotation for firewood, standards being retained for another period of 20 years in order to yield timber.

Water requirements. During the whole rotation the trees require ample water from April to September, at the rate of about 1 cusec to 80 acres of plantation. Water is needed particularly when the leaves appear in early spring. Whenever there is excess water in the canals it should be diverted to the forest as the trees benefit greatly from additional irrigation.

Soil. Sand and stiff clay are equally unfavourable. A sandy loam or a good loam soil is required. Soils impregnated with salt are unfruitful, but small patches of saline soil may be ignored as conditions improve later on with irrigation.

Situation. The plantation should be situated near the head of the canal *and never at the tail, in order that spare water may be used easily*. Carriage of bulky firewood by road is expensive, and the plantation must be situated along a railway.

Temporary cultivation. Supposing that 8,000 acres be decided on as the area required, then in the 1st year 400 acres would be planted and 400 acres, would be trached and laid out for the next year's planting, leaving 7,200 acres for temporary cultivation, which would diminish by 400 acres yearly. During the course of formation the revenue from field crops would more than repay the total costs of establishing the plantation.

Establishment required The staff required to begin with would be one Forest Ranger, 4 foresters and 12 forest guards, to be expanded later on as work developes.

FINANCE. Sir Herbert Howard gave figures for the revenue and expenditure for the 5 years ending 31st March 1939. The following table gives similar figures for the 5 years ending 31st March, 1944.

Statement showing Revenue, Expenditure and Surplus of the Baluchistan Forest Department for the last five years 1939-40 to 1943-44.

Budget Heads.		1939-40		1940-41		1941-42		1942-43		1943-44.	
		Rs.	a. p.	Rs.	a. p.	Rs.	a. p.	Rs.	a. p.	Rs.	a. p.
Major Forest produce	....	27,958	0 6	26,043	5 6	46,856	1 9	1,35,062	10 3	64,731	7 3
Minor Forest produce	....	1,14,723	4 2	94,582	13 7	1,47,380	11 2	36,623	7 3	1,53,260	13 0
Miscellaneous sources	...	4,903	10 11	6,525	7 3	5,328	12 9	8,988	6 8	21,558	13 0
Revenue from unclassified forests	....	12,972	10 3	12,202	3 0	11,352	11 0	14,894	11 6	12,232	2 0
Total	....	1,60,557	9 9	1,39,353	13 4	2,10,918	4 8	1,95,569	3 8	2,51,783	3 3
Refund or deduction	....	....	....	-51	13 0	....	....	....	....	....	....
Total Revenue	....	1,60,557	9 9	1,39,302	0 4	2,10,918	4 8	1,95,569	3 8	2,51,783	3 3
EXPENDITURE.											
Extension, Constitution, improvement and exploitation of forest property	....	1,09,147	4 0	81,916	11 8	1,46,893	5 9	1,92,673	9 9	2,74,310	2 6
Administration executive and protection charges	....	37,848	11 0	39,404	12 0	41,565	3 0	50,211	8 0	57,501	14 9
Total	....	1,46,995	15 0	1,21,321	7 8	1,88,458	8 9	2,42,885	1 9	3,31,812	1 3
Refund or deduction	....	....	....	....	....	....	....	....	....	....	....
Total Expenditure	....	1,46,995	15 0	1,21,321	7 8	1,88,458	8 9	2,42,885	1 9	3,31,812	1 3
Surplus	....	13,561	10 9	17,980	8 8	22,459	11 11	....	....	....	....
Deficit	....	....	....	....	....	....	....	-47,315	14 1	80,028	14 0

These figures take no account of the very considerable stocks of firewood, ephedra etc., which were in hand at the close of each year.

The financial position.—The following statement for the last 3 years gives the true financial position :—

Statement showing Revenue, Expenditure and Surplus of the Baluchistan Forest Department for the last three years i.e. 1941-42, 1942-43 and 1943-44.

EXPENDITURE.

1941-42.

1. Value of stocks in hand at cost price at the beginning of the year i.e. 1-4-41	....	.... = 40,435 6 6	1. Value of stocks in hand at cost price	....	.... = 26,764 7 0
2. Expenditure booked during the year	....	.... = 1,88,458 8 0	2. Revenue recovered and credited during the year	....	.... = 2,10,918 4 8
3. Outstandings of Revenue at the beginning of the year i.e. 1-4-41	....	.... = 4,672 8 0	3. Outstandings at the end of the year i.e. 31-3-42	....	.... = 8,899 14 6
4. Surplus	....	.... = 8,016 2 11	Total	....	.... = 2,41,582 10 3
Total	....	.... = 2,41,582 10 3			

1942-43

1. Value of stocks in hand at cost price at the beginning of the year i.e. 1-4-42	....	.... = 26,761 7 0	1. Value of stocks in hand at cost price at the end of the year i.e. 31-3-43	....	.... = 59,335 15 0
2. Expenditure booked during the year	....	.... = 2,12,985 1 9	2. Revenue recovered and credited during the year	....	.... = 1,95,509 3 8
3. Outstandings of Revenue at the Beginning of the year i.e. 1-4-42	....	.... = 3,559 11 6	3. Outstandings at the end of the year i.e. 31-3-43	....	.... = 14,628 9 10
4. Deficit	....	.... = 2,73,519 7 3	Total	....	.... = 2,69,433 13 6
Total	....	.... = 4,115 10 9			
Total	....	.... = 2,69,433 12 6			

1943-44.

1. Value of stocks in hand at cost price at the beginning of the year i.e. 1-4-43	....	.... = 49,499 1 0	1. Value of stocks in hand at cost price at the end of the year i.e. 31-3-44	....	.... = 1,59,114 1 0
2. Expenditure booked during the year	....	.... = 3,31,813 1 3	2. Revenue recovered and credited during the year	....	.... = 2,51,783 3 3
3. Outstandings of Revenue at the beginning of the year i.e. 1-4-43	....	.... = 13,692 6 3	3. Outstandings at the end of the year i.e. 31-3-44.	....	.... = 48,231 0 0
4. Surplus	....	.... = 64,178 1 9	Total	....	.... = 4,59,181 10 3
Total	....	.... = 4,59,181 10 3			

Stocks.

The stocks in hand are very high owing to:—

(a) the formation of a reserve of firewood.

(b) accumulation of ephedra stocks owing to rail transport difficulties.

It is essential to get rid of the ephedra as soon as possible as the drug is liable to be leached out by rain.

For some years shortages in firewood have been carried forward in the books. Stock must be checked now, and annually in future, and shortages should be written off under due authority.

Outstandings.

The outstandings of revenue Rs 48,284/6/0 at the end of March 1944 are high. Special notes have been made in the office inspection report for the information of the Accountant General and for necessary action.

The surplus.

The true surplus of Rs. 64,178/- is high and is due to the exceptional demand for forest produce created by the war. Money will be required for soil conservation, and I would suggest that a Development fund be started by transferring Rs. 50,000/- to it now, and more later on each year while times are prosperous.

46. The Budget 1944-45.

The sanctioned budget for 1944-45 provides Rs. 70,000/- firewood and charcoal, Rs. 90,000/- for ephedra and minor forest produce and only Rs. 100/- for roads and bridges and Rs. 1,500/- for buildings. These last sums are utterly inadequate.

47. Roads and Bridges.

There are a few bridle paths in the forests which are kept up by Political Agents, all of which are out of repair.

48. Buildings.

The accommodation for the forest staff is most inadequate and the Forest Officer should submit a programme now for housing the subordinates staff within 5 years.

49. The economic implications of the Forest Budget expenditure.

Some Rs. 7,68,000/- or Rs. 2,54,000/- yearly have been spent in the last three years, mainly in rural areas, which is of great importance in an impoverished tract. There is no possibility of the firewood supply being maintained: but there is every need to develop the supply of ephedra and other herbs in the interests of the people and of Government.

That a surplus has been made is very satisfactory, even more so is the fact that the people have been able to earn money by working in the forests. It is likely that the demand for ephedra and other medicinal herbs will continue and will increase, and this makes it all the more necessary to protect the drug producing forests from over-grazing which destroys the plants which produce the drugs for commercial development. In fact care must be taken not to kill the goose that lays the golden eggs.

50. Possible developments.

Firewood.—An irrigated plantation in the plains is required for which suggestions have been made.

Pencil cedar.—In three years the stock of dry wood in accessible forests will be exhausted. Green trees would be suitable, though only 5% of the outturn is fit for use, and might be felled sparingly under a sanctioned working plan, and allowed to season for 5 years before use.

Ephedra.—This valuable species should be protected from grazing. Already the sales total Rs. 1,00,000/- a year and the industry is capable of development, for which the Jirga Forest Schemes would afford ample opportunity, collection and marketing being organised by the Forest Officer. The bushes should be lopped once only in 3 years. Storage sheds are required at all main centre of collection and storage.

Pyrethrum.—The experimental nurseries formed under J. Clinton Bond's guidance have been most successful. It is important to extend the area under pyrethrum, and as no suitable Government land is available the zamindars should be induced to grow it in their fields. Four men are ready to do so and part of Mr. Bond's duties should be to induce the zamindars to grow pyrethrum and to advise on its cultivation, drying and storage. There are 100 lbs. of seed available now.

Drugs.—The direct concern of the Forest Department is the protection from grazing of the areas in which drugs yielding plants grow. The minor Forest Products expert to be appointed in the Agricultural Department should now take charge of research and development assisted by Mr. Bond, who has unique practical experience of the growth, behaviour and properties of herbs and drug containing plants. The Woodcock spinney nurseries are available for testing and cultivating species which now grow wild in the forests and of their culture Mr. Bond should be incharge.

51. **Conclusion.** Before a final decision can be made on the organisation of Forest Administration in Baluchistan Government must decide on the policy that it is going to adopt in view of the serious extent of erosion. The passage of herds of animals to and from Afghanistan, the Punjab and Sind may cause Political Officers to be disinclined to take action that they recognise to be necessary; but unless some action is taken now to regulate the grazing the greater part of the country will become a barren waste. In the writer's opinion Government should not hesitate to announce as its policy the conservation of the soil and the prevention of erosion throughout Baluchistan; but while deciding to take compulsory action to close the forests and pastures in rotation should that eventually be required, every opportunity should be given to the people to co-operate with Government voluntarily in a scheme of pasture management based on the prevention of avoidable soil erosion, and the maximum use but not abuse of the vegetation and the permanent association of man and his animals with the land.

It would be of advantage for the Soil Conservation Service to be part of a Federal Forest Service as suggested by Sir Herbert Howard in his pamphlet on Post War Forest Policy.

Dated, Ziarat,

The 7th July, 1944.

H. M. GLOVER.

APPENDICES.

APPENDIX I.

STATEMENT OF FOREST RANGERS, DEPUTY RANGERS & FORESTERS REQUIRED.

<u>Head Quarters.</u>		<u>Duties.</u>
Assistant	... 1 Forest Ranger	... Ephedra, firewood and drug supply.
<u>Rangers.</u>		
Quetta-Pishin	... 1 Forest Ranger	in charge.
	1 Deputy Ranger	general assistant.
	3 Foresters	{ Quetta depot. Pishin block. Urak block.
Chagai	... 1 Deputy Ranger	in charge.
	1 Forester	at Nokkundi.
Ziarat-Harnai	... 1 Forest Ranger	in charge
	2 Foresters	{ Harnai depot. Ziarat depot
Sibi	... 1 Forest Ranger	in charge.
	1 Deputy Ranger	Sibi ephedra and firewood depots
	2 Foresters	for depots as above
Loralai	1 Forest Ranger	in charge.
	3 Forester	depots and protection.
Zhob	... 1 Deputy Ranger	in charge.
	1 Forester	protection and general assistant.
<i>Total</i>	<i>Required Staff</i>	<i>Present Staff</i>
Forest Rangers	... 5	2
Deputy Rangers	... 4	3
Foresters	... 12	7
Temporary Establishment } as required from Droghas for ephedra etc, } time to time.		} nil

NOTE :—(i) This is about 60% of what Forest Officer considers to be necessary

(ii) The staff would be recruited gradually and trained, the Conservator advising on necessary increases from time to time.

APPENDIX II.

THE ZHOB DISTRICT.

The Zhob district has an area of 10,478 square miles and consists of steep sided valleys and high mountains rising to 11,000 feet. The Zhob river runs through a flat open valley. Part of the country is very rugged.

The average rainfall at Fort Sandeman (4,700 feet) is 11 inches, but at higher elevation to the north east it must be considerably higher, judging by the general appearance of the vegetation and the vigorous growth of the olive, *kanyak* and ash trees, which, although they have been mutilated, show that the country is capable of producing good forests. There is less rainfall in the west, and at Hindubagh the average rainfall is only 7 inches and there is no tree forest. There are high winds and intense cold in the winters. The rainfall varies considerably from year to year and in different tracts and at Hindubagh in 1942 was 16 inches, or more than 100% above normal, while in that year the rainfall at Fort Sandeman was normal. The summer moonsoon just reaches the Zhob district. Occasionally there are severe storms when much rain falls.

The forests. On the Shinghar ridge are *chilgoza* (*Pinus gerardiana*) forests, which consist of old overmature and dead trees with very little stock, with an understory of *cragana*, *ephedra* wild almond, ash and *pistacia*, all heavily overgrazed.

The forests are disappearing, but now a first attempt is being made to preserve them, some 4 square miles having been reserved at Shinghar and closed to grazing in June this year.

The olive forests. The central and western parts of the district consist of barren hills with no tree forests at all. In the east of the district there are very extensive olive forests which consist of ancient pollard trees of olive, *kanyak* and ash, and much browsed olive bushes. At one time the forests in the valleys were comparatively densely stocked, while the higher slopes were dotted with trees.

All the forests are very much overgrazed, the soil cover has been destroyed, the soil has been, and is being, very heavily eroded, many of the trees within economic distance of Fort Sandeman have been felled, and the nearer forests have largely disappeared. A few hundred acres of very thinly stocked olive forest have recently been reserved and closed to grazing but the crop is very open and the ground is eroded.

Generally the forests now are the ruined remains of what was at one time a well afforested country. Grazing must have been heavy even before the British occupation, but in this last 50 years or so it has greatly increased and now is far heavier than the forests can possibly stand.

Forest Management Attempts have been made to prevent the felling of green olive and *kanyak* trees by inserting conditions that dry trees alone are to be felled, in the contractors' agreements for supplying firewood to the Army and Zhob Militia stationed at Fort Sandeman. For many years past it has been customary for the people to cut green trees, let them dry for some months in the forests and then supply the fuel as dry firewood, thus evading the rule.

On several occasions in the past various Forest Officers have suggested regular coppice fellings to be followed by closure to grazing in order to let the young coppice shoots grow beyond the reach of goats, but no organised fellings have ever been made, and except in the recently reserved Kapip and Shinghar forests no area has ever been closed to grazing.

The forests were under the sole charge of the Political Agent, Zhob, until 1938, who has been assisted for the last 20 years or so by a forester and 6 guards stationed at Shinghar. Occasionally, from 1892 onwards the Chief Forest Officers of Baluchistan were requested to visit the tracts and advise: their reports are still under consideration.

In 1938 the Forest Officer assumed charge of the forests, and organised the firewood supply and the collection of ephedra, of which large quantities exist, but the protection afforded to the forests has been nominal. A Deputy Ranger was placed in charge and he is assisted by an untrained forester, (at present the forests of the district, which are scattered over an area larger than the whole of Wales, are managed by the Loralai Range Officer, in addition to his normal charge).

The forests of the Zhob district are doomed if present lack of management continues. Organised management accompanied by closure for long periods might eventually restore the forests, but years of neglect have made this exceedingly difficult. The present Political Agent, Lt.-Col. Searl has taken great interest in the forests and has attempted to improve their condition but he is handicapped by an utterly useless forest staff and a complete lack of understanding by the local inhabitants of the need for protecting the forests.

Economic background. The people are backward and undisciplined, and the country is administered as tribal territory. There are only 6 persons per square miles which makes administration both difficult and costly. There are fine military motor roads, but no carts are used for transporting agricultural products. There is no major industry other than grazing. Fields are few but are well cultivated for wheat and millets. There are chrome mines at Hindubagh where labourers earn good wages, but there are not sufficient men willing to work in the mines. The tribal leaders are subsidised by Government, the young men are employed as levies or in the Zhob militia, and none join the Army even in time of war. There are few schools and no desire for education.

Grazing. Numerous sheep and goats are kept and some graze for part of the year in Afghanistan: migratory flocks and herds of camels from Afghanistan crowd into the valleys in the winter, and either remain or go on to the Punjab; paying *tirni* enroute to the Baluchistan Government.

Grazing is economically very important, but there is no pasture management and the grazing industry is entirely unorganised.

Soil erosion. There is surface erosion everywhere, both on the hills and on the gently sloping plains. Much damage is done to the roads after every storm of rain. The vegetation is much less plentiful than it should be, and indeed must have been in former years, and erosion is on the increase owing to the destruction of the vegetation by grazing.

Suggestions for future management. The first thing to do is to get the Maliks and the leaders of the tribes to recognise that some form of management is necessary. Otherwise it would be useless to reserve forests in which trespass would be universal. The Soil Conservation Officer should visit the tract, and get the people to recognise the value of conserving the forests and pastures and then approximately 1,500 square miles of forest should be demarcated and protected and improved by means of rotational closures. There is money to be made out of ephedra, fuel and chilgoza seed and out of miscellaneous herbs, while the advantage of managing the pastures in a manner which will ensure better use of the vegetation should appeal to the people. The present forest staff is utterly useless and is quite incapable of doing any effective forest work, whatever form of management may be suggested, and should be got rid of. Any forest ranger should be placed in charge, assisted by 8 good foresters and the necessary forest guards, whose duties should be protection and supervising the extraction of firewood and ephedra and to prepare the people for an advance in forest management.

Such of the suggestions as have been made in general note on Baluchistan as are practical should be adopted in the Zhob district and meanwhile a start should be made in the demarcation and notification of 1,500 square miles of forest.

APPENDIX III.

THE CHAGAI DISTRICT.

The Chagai district extends to the borders of Persia and Afghanistan and is of area 19,428 square miles. It is exceedingly thinly populated, 2 inhabitants per square mile, and the people live mainly by grazing herds of goats, sheep and camels, while there are numerous donkeys and few cattle. There is but little arable cultivation, 29 square miles of Rabi wheat and 7 square miles of kharif crop.

The barren sandy and stony desert tracts beyond Dalbandin lie beyond the scope of the present survey.

The Kaiser river catchment area.

The Kaiser river flows past the Nushki town in a wide stony bed, debouching from the hills and spreading over the plain in numerous small channels in a manner similar to that of the *chos* of the Hoshiarpur district of the Punjab. Its waters are used for the Nushki town supply and for irrigating fields lower down its course, where all the water is absorbed.

History.

In May 1938 the Political Agent, Chagai, drew attention to the condition of the Kaiser river basin and particularly to the denudation of its catchment area in the hills and asked for its protection in a strongly worded letter in which he said "owing to apathy or antipathy of successive District Officers the control by the Forest Department was removed and since then the jungle has been steadily denuded. What is required now is :—

- (a) An effective system of control.
- (b) Gradual re-afforestation."

On 8th October 1938 he wrote as follows:—

"Although the Revenue Commissioner in 1923 stressed the point that reservation would lead to the local administration being cursed in the next generation; I would point out that unless action is taken to reserve the forest now the next generation will indeed curse the local administration for not taking adequate steps to protect its water supply. It is for this reason, and not because I wish the jungle to be a directly paying proposition to the Forest Department that reservation is necessary. If the Kaiser Water Supply dries up the cost to Government will be out of all proportion to the cost of reservation."

220 square miles of the catchment area were reserved in 1940, but no forest settlement was made, and the only effect of reservation has been to preserve a valuable patch of 800 acres or more of tamarisk forest.

1/20th of its former extent, but I could not verify this. Before describing conditions in the catchment area I will give a short note on this forest.

The tamarisk forest.

The Kaiser river flows at 4,000 feet above sea level in a permanent stream of water through a long valley floored with alluvium on which thick tamarisk jungle grows on either bank. The river is subject to sudden floods, and in 1938 and again in 1944 carved channels through the forest and uprooted and washed away tamarisk trees and bushes.

The tamarisk has been coppiced irregularly in the past and seedlings appeared on the bare moist soil, and there now is a dense mass of coppice shoots and young plants up to 15 feet in height. This forest should be managed properly as coppice for the supply of firewood and small shoots for basket making and huts according to a working plan, which should be properly prepared and should prescribe the closure of all areas felled over for 5 years after felling.

The rotation to begin with should be provisionally fixed at 20 years pending the obtaining of figures of the rate of growth of the coppice shoots. Meanwhile 15 acres should be clear felled annually, and the remainder should be gone over in proper cleanings on a 5 years' cycle. To begin with 50 acres may be thinned this year pending the correct measurement of the area. The thinnings must be correct silvicultural operations, and the average espacement, pending further experience of the rate of growth may be 6 to 8 feet. Even so far down as Nushki tamarisk seedlings were seen in the nullah bed, but they are eaten at once by goats: with protection it should be possible to extend the area covered by tamarisk which seeds profusely.

The Kaisar catchment area. A vast extent of hills and valleys, reaching to Afghanistan and rising from 3,167 to 6,226 feet above sea level, forms the catchment area of the Kaisar river. There is a very scanty flora of much browsed *Artemisia brevifolia* and *amriin d* and spiny plants, all widely separated one from another. The catchment is in thoroughly bad order and is grazed by thousands of local goats and by flocks from Afghanistan. Near civilisation, so called, the hills have been stripped of practically all vegetation. The condition of the catchment area is so very bad that nothing but long continued closure could possibly restore it so as to afford protection to the soil and prevent disastrous floods.

The bottoms of the valleys have been formed into fields by diverting the silt laden floods in most ingenious ways, so as to form fields on silt deposited behind embankments in the course of several years. Numerous dams have been breached by storm water last winter and spring, owing to the floods. Great damage has been done to the fields, but already, with the help of bullock-drawn scoops, the earthen dams are being rebuilt, but many fields will not yield a tithe of their former grain until many years have elapsed. This in a poverty stricken country where grain is never sufficient to feed the people, is a disaster. The cure is the closure of the catchment area to sheep and goats. To begin with one third, namely the upper catchment area of each main and tributary valley should be closed absolutely to all grazing, and protests by the villagers should not be accepted. I would suggest that in the remaining two-thirds of the area attempts should be made to induce the villagers by the remission of *timi* to rotate the grazing grounds so that one half is always closed to grazing. Much and continuous propaganda, and explanation of Government's beneficent intentions would be necessary, and political Agents might explain to the people why closure is required.

The Chagat Noseri. I went from Nushki 67 miles to the West along an upland plain at a height of about 3,000 feet, stopping and seeing the country on either side of the road. The plain is bordered to the south by the Raskoh mountains, which consist of naked, jagged lava rocks with a few xerophytic bushes and grasses of the species which cover the plain. Such vegetation as there is is all heavily browsed. Against these hills sand collects, blown by the north west wind and gradually grasses and bushes obtain a precarious footing, and, in time would fix the sand in place if they were able to survive in face of the grazing. Below the hills is a stony upland plain sloping to the north, at first towards cultivated wheat fields irrigated by the flood waters of the Kaisar river, and later, as that valley is left behind, towards a salt depression. As one journeys to the west sand dunes are met with on which there is a thin scrub and desert bushes.

The upland plain in front of the hills. For some miles from Nushki the soil is stony and there is little vegetation other than bushes of *Rhazya stricta*, which is not eaten by animals. Further on and nearer the hills there is a fair covering of bushes, amongst which the following are conspicuous: *Artemisia brevifolia*, *Rhazya stricta*, *Haloxylon griffithii*, *Pycnocycla aucheriana*, and *Stocksia brahuira*, a few *ephedra* bushes and *Periploca pithylla*. There are large clumps of *Pennisetum dichotomum* grass, some *Eleusine flagellifera* grass and minute herbs and grasses. There had been heavy rains in the winter which had broken the main road in many places. The surface run off for several miles must have been very

great, and a vast amount of top soil has been carried away by sheet erosion which has been severe because of the deterioration of the protective cover of the natural vegetation which no longer affords sufficient protection to the soil. Goats in considerable numbers were seen grazing in the desert, and I formed the opinion that far more are kept than the vegetation can support, and that the vegetation itself has suffered severely and will deteriorate very rapidly unless it is protected by rotational closures accompanied by the limitation of flocks to numbers which the vegetation can support. It may seem strange to talk of water as opposed to wind erosion in the desert where the average annual rainfall (8") is very low indeed: but it is characteristic of this desert country for severe thunderstorms to occur at widely separated intervals when much rain falls in a very short time, and where the natural cover of the soil has been destroyed the storm water washes away the whole of the top-soil.

There is a small amount of dry cultivation in fields which are embanked to retain the water which collects from the hills. Numbers of the embankments have been broken by storm water, as there were no escapes whereby excess water could be disposed of safely.

Up-to-date no attention whatever has been given to the protection of the desert flora. It is grazed to beyond its capacity and bushes are cut or dug up for fuel to a distance of many miles from Nushki and round all railway stations and large villages.

Below the stony uplands and towards the salt depression there are at places quantities of *Sarlas* grass, *Saccharum ciliare*, which maintains itself in spite of grazing.

The sand desert. At Chandram, mile 67 from Nushki, an excursion was made into the sand dunes, which are formed by sand drifting with the north west wind and appear to overlie a layer of clay soil to heights of 80 to 200 feet. They are thinly covered by a desert flora different from that of the stony uplands although some of the species are the same. The surface of the sand dunes is rippled by the wind and particles are detached from its surface wherever there is no protection from bushes or grasses. The bushes in the valleys, and particularly the dwarf *taghaz* tree (*Haloxyylon ammodendron*), stand on isolated heaps of soil owing to the effects of wind erosion. There are the remains of a very large graziers encampment, abandoned.

The main species are *Haloxyylon ammodendron*, *Calligonum comosum*, *Astragalus* sp., *Pycnoscyela wucheriana*, *Salsola arbuscula*. The small grass which appears after rain, only to seed and dry up in a few weeks *Panicum melaceum* helps to hold the sand in place, so does the grass *Stipa pennata*. In other sandy areas the grasses *Saccharum ciliare*, *Eragrostis* sp., and *Andropogon uncalatus* were common but they were not seen at Chandram. The *taghaz* trees have all been coppiced, with shoots now upto 10 feet in height. They are used for fuel and for making hats. The shoots appear from thick root stocks upto 15 inches in diameter which are immensely old. The annual rings are distinct but as the majority of the stumps are hollow their age could not be determined exactly, but some trees are certainly well over 200 years in age, and the average of the stumps seen at Ahmedwal railway station was well over 100 years. The roots run far into the soil and the *taghaz* tree performs a most useful service in fixing the sand dunes, when other species, and particularly the grasses mentioned above, hold the surface of the dune in place.

Excessive grazing destroys this surface vegetation and the sand drifts and is blown about by the wind. Recently the roots of the *taghaz* tree have been dug up for fuel for Quetta and for encampments. At Ahmedwal railway station there was a dump of 1,600 maunds of *taghaz* roots. This tree should be strictly preserved as with its deep root system, developed over centuries, it serves to fix the sand dunes which otherwise will advance towards the east. An advancing desert accompanied by general aridity is the future of the Chagai district if grazing and exploitation of the natural vegetation for fuel be permitted without efficient control.

Staff. There are one untrained forester and 3 forest guards at Nushki and 1 forest guard at Nokundi, 100 miles east of the Persian border. The staff is utterly inadequate, and if Government decide to conserve the soil, as will be suggested later on, trained staff will be required. A separate chapter will be devoted to the staff needed throughout Baluchistan.

APPENDIX IV.

DIARY AND TOUR NOTES.

3-5-1944
Woodcock spinney Area 52 acres. Situated on both sides of Smungli road. Part covered with ash, willow, fruit trees. Remainder to east of road is partly under Agricultural Department as a vegetable seed farm (14 acres) and 10 acres under Forest Department for growing pyrethrum.

Pyrethrum plantation. Irrigated by sullage water. 3 acres have been planted up in all. 2/3rd acre planted in 1942 now bears very fine plants indeed, with from 100 to 200 flower heads. It is true that the leaves of some of the plants are turning yellow but this may be due to the acidity of the sullage water. The experiment has been most successful. The plants have seeded and the numerous seedlings will be of use for planting up the land which is now being levelled. The yield from 2/3rd of an acre has been 104 lbs of seed and 30 lbs 10 oz of dried flowers. The pyrethrin content is as follows:—

	Pyrethrin I	Pyrethrin II	Total.
Sullage water plot	0.57	0.50	1.07
Fresh water plot	0.42	0.29	0.71

This compares with the yield from other localities as follows:—

Locality.	Altitude.	Annual rainfall.	Normal rainfall in July, August & Sept.	Pyrethrin I	Pyrethrin II	Total Pyrethrins.
<i>Kashmir</i>	ft.	in.	in.	%	%	%
Tangmarg ...	7,200	15 + winter snow	11	0.35	0.57	0.92
Baramulla ...	5,200	38	6	0.32	0.62	0.94
<i>Punjab</i>						
Palampur ...	4,500	101	72	0.22	0.68	0.90
Murree	7,118	57	31	0.37	0.66	1.03
Kulu ..	4,500	39	15	0.35	0.40	0.75
<i>N.W.F. Province</i>						
Tarnab ...	2,000	17	6	0.31	0.59	0.90
<i>United Provinces</i>						
Dehra Dun ...	2,239	87	59	0.63	0.15	0.78
<i>Garhwal</i>						
(Pandar range) ...	4,000	70	44	0.29	0.28	0.57
<i>Madras</i>						
Kodaikanal ...	7,688	62	19	0.76	0.62	1.38
Ooonoor ...	5,730	64	10	0.44	0.45	0.89
<i>Assam</i>						
Shillong -4 ...	4,921	84	40	...	....	1.41
<i>Orrissa</i>						
Mayurbhanj-6 ...	1,600	60	32	...	....	1.15
<i>Mysore</i>						
Bangalore-5 ...	3,021	35	16	...	....	0.80
Kenya ...	7-9,500	40-65	...	0.77	0.56	1.33
Japan ...	....	40-80	....	0.38	0.63	1.01
Dalmatia ...	....	40	....	0.35	0.63	0.98

4-5-1944. Penall factory, 48 Slats for 1 gross pencils $2\frac{1}{2}'' \times 7\frac{1}{2}'' \times \frac{1}{2}''$. 6 ply give
Owner Mr. Ganguli. 6 pencils per pair of slats. Delivered 3/- at any Punjab
Railway Station; at Bombay, Calcutta and Madras Rs. 8/8/- and U. P.
Rs. 8/4/-.

Demand during war is unlimited. Peace time competitive. African prices -/14/- at Calcutta. At present 2 saw benches for slat making, planing, grooving, rounding and painting are done by hand. Special machines on order (some enroute and some have arrived but have not been unpacked:—

Graphite grinder: lead moulds: grooving machine: sand "papering" machine: painting machine: printing machine circular saw for end cuts which together make one complete set for an estimated outturn for 26 to 35 gross pencils daily).

Present stock of wood at saw mills 1,200 maunds.

For every 100 lbs. received at saw mills the outturn is as follows:—

Slats 5 lbs.

Sawdust 7 lbs.

Dryage (absolute loss) 11 lbs.

Firewood 77 lbs.

Present daily consumption 100 maunds of raw wood for 4 mills.

Estimated requirements for the new machinery = 3,000 pounds daily.
= 1½ tons

Sawmill. Dry fallen juniper wood is used. Quality very poor and trees old, and knotty. Grain is moderately straight. Much of the timber is branchy or actually rotten and unsound.

The logs are of the lowest quality I have ever seen used in any industry other than wood wool for Insuloreta.

Deodar and fir have been tried experimentally but have proved to be unsuitable as they are not sufficiently soft and do not cut easily. Blue pine might be better.

Dhobi Ghat Reserve. Area 10½ acres, situated partly inside and partly outside Municipal limits. A long stretch of forest on both sides of a line of springs and a water channel. Crop consists of willow, sinjed, (*Elaeagnus angustifolia*), hawthorn, ash, apricot, and mulberry with grass and herbs. Quite useful for supplying posts and pea sticks. The land has been encroached on by the Police and by the brother of the Khan of Kalat. To the north west of Five Springs road the forest is traversed by the Gymkhana road and cannot be protected. This part might be disforested.

Quarters. Subordinates quarters, and Forest Officer's house are only temporary shelters. Accommodation is urgently required.

Depot. Firewood 10,33,900 lbs.

Ephedra 700 maunds collected by locals.

The Ephedrine factory owned by Mr. Marker was visited. It consumes 7½ maunds of Ephedra Vulgaris shoots daily. The details of the process were explained in such an unintelligible manner that I formed the opinion that the Management wished to conceal trade secrets. They pay Rs. 10/- per maund delivered at the factory. Other firms pay the same. It might be advisable to call for tenders for next year's supplies.

5-5-1944

From Quetta to Mari Chak reserved forest. The route lay across a plateau gradually rising to about 5,750 feet, and formed of detritus from the steep limestone hills. The rainfall is low, about 10" and the soil is thinly covered by plants of *Artemisia brevifolia*, *Sophora griffithii*, small herbs and very little grass, which is inconspicuous. This upland forms a grazing ground for numerous animals, particularly sheep and goats. It is traversed by a small water-channel from the Ghundak stream and by stony dry water courses, which become torrents after thunderstorms which occur at rare intervals when a considerable quantity of rain falls in a very short time. This plain and the hills which surround it are fit only for use as grazing grounds. It would be desirable to manage them properly as such, and to close portions in rotation in order to permit of the recovery of the vegetation. This would mean an orderly scheme of village pasture, (or forest) management, which may sound ideal under present circumstances, but is quite practicable, as experience is showing in Kangra in the Punjab, where a few years ago no one would have expected that the village waste could have been brought under management with the consent of the people.

The road runs up the Gundak valley towards Ziarat, the stream having permanent water, and then a path branches off to the West.

There are bushes and *Succcharum munja* (var) grass in the bottom of the valley and golden eremurus are in full bloom but the slopes are only thinly covered or are bare, and the earth is scoured by erosion. The road lies up the valley to Shanglun chak where there are springs and a very few fields which are irrigated but have not been properly terraced and levelled. Grazing is heavy enough to have resulted in the limestone rocks having been exposed and only a thin soil is left.

At 8,250 feet above sea level the Mari Chak reserve forest begins and extends along both sides of the valley for some miles to precipitous heights of 11,390 feet covering an area of 1,830 acres. All is closed to grazing and the valley is said to contain herds of *gad* (*Ovis cycloceros*) and straight horned *markhor*. There are a few scattered *Juniperus excelsa* (Macropoda) trees, some *ash* (*Fraxinus xanthoxyloides*), *Pistacia khanyak* and bush like wild almond (*Prunus eburnea*) trees of small size and *caragana* and many thorny bushes, *Artemisia maritima*, and *Ephedra vulgaris* plants upto 3'-6" in height, some of which have been lopped for sale to factories. There is some thin grass, many herbs, pink eremurus lilies and some *Salvia* and *taraxicum* plants in flower. Protection has been excellent and the soil, derived from limestone rock is thicker than is usual on limestone formations, except on the steeper hillsides. The forest is serving a most useful purpose in protecting the hillside from erosion.

5-5-1944

Hazarganji Reserved forest, 5,440 acres. Notified and closed in 1890. There are no rights of user and there is no village nearby. The forest varies in elevation from 6,826' to 10,870' above sea level. The upper half is very rocky and precipitous, but juniper trees of immense age cling to the slopes. The rocks, which are of limestone throughout dip towards the north east. On the shoulders of the hills there is a good depth of soil, except where the slope is very steep. There is a thin but sufficient ground cover of

Caragana ambigua and *Gerardiana Sophora Griffithii*, wild almond (*Prunus eburnea*) and *Prunus cerasus* (wild cherry), some *Ephedra Vulgaris*, numerous herbs and some grasses. There are a few very old *Pistacia khamjak* trees and some ash (*Fraxinus xanthoxylodes*). At the bottom of the hill the reserve lies on the upper portion of a stony upland undulating plain covered with *Alhagi camelorum*, *Sophora Griffithii*, *Artemisia brevifolia*, *Caragana ambigua* and fair crop of grass. There are also large and very old trees of *Pistacia khamjak*, a good number of which were felled in 1942 for the Quetta fuel supply and show no signs of regenerating. There is a thin stock of old ash with some young saplings. *Daphne oleoides*, *Convolvulus spinosus*, *Salvia kabulica* bushes are also met with. There have been big rock falls, said to date from the earthquake in 1935, but it looks as if subsequent thunder-storms had carried detritus out into the plain since then. The floods have not gone far as they have been dispersed and absorbed a short distance down the plateau.

The forest is serving to arrest erosion and should be protected. None other than dead trees should be felled on any account.

The neighbouring hills of the Kalat State are rocky and barren with hardly any soil or soil covering.

8-5-1944. Spin Kares catchment area. Situated a few miles north-east of Quetta with an area of 28 square miles. The dam is at 6,500 feet above sea level and the hills rise to a maximum height of 9,723 feet. The rocks consist principally of limestone forming scrapes on either side of the valley. The lower slopes are formed of soft earth and coal is mined at the surface. The valley is wide and floored with detritus, forming a stony plateau covered with thin and much browsed herbs of *Artemisia brevifolia*, *maritima*, *Withania coagulans*, *Sophora Griffithii*, *Alhagi* very short and thin grass and small thorny or xerophytic plants, each plant being separated from its neighbours by bare earth. The whole area had been very heavily grazed until a year ago when it was closed and it will be notified as a reserved forest closed to all rights. Already there is a slight improvement in the growth, and grass is spreading very slowly. Some of the slopes are completely bare and are scoured with gullies. Higher hills have a thin covering of herbs amongst which are a very few scattered Juniper trees.

The run off after rain is considerable, and the Government has most wisely closed the whole catchment area, otherwise the reservoir would be filled with detritus within a few years. It would be interesting to make a detailed botanical survey of the vegetation in order that ecological changes consequent on closure may be recorded. I would suggest that the area immediately below the dam should be closed as reserved forest. There will be some seepage, which might make it possible for herbs and trees to grow.

8-3-1944. Zargun Reserved forest. Through the lower part of the Zargun reserved forest which is of 17,180 acres in area and forms the catchment area for the Quetta water supply. Elevation 5,907 to 11,730'. The rocks consist of massive conglomerates and sandstones. There is permanent water in the nullah which is fed by small springs. There has been much rain this spring and the soil below the surface is still moist.

The forest was reserved in 1901 and since then has been completely closed. Cultivators were excluded. It is quite evident that in the neighbourhood of the fields grazing was very heavy and the soil was eroded. Here vegetation is still very sparse but elsewhere it forms a very fair covering to the soil, apart from the rocks which are either precipitous or steeply tilted and from

which soil disappeared many years ago. The whole association of plants is sufficiently dense to prevent much soil erosion, and together form, what may be termed a botanist's paradise as there are numerous species of aromatic herbs. The trees are all small and often are bush like. Those seen were:—

Trees. *Juniper macropoda*. Widely spaced and branched to the ground, with many of younger age. *Pistacia Khunjuk*—A few only and all small. *Prunus eburnea*—bush like, *Prunus cerasus* (wild cherry). *Ficus carica*, willows, Walnut, Ash, planted with the help of irrigation.

Bushes. *Caragana Gerardiana* and *Ambigua*: *Grewia populifolia*, *Ephedra vulgaris*, *Bariar*, *Rudleia*, *Withania coagulans*, (at lowest levels) *Salvia Kabulica*—*Convulvulus spinosus*, *Sophora Gaiiffithii*.

Grasses. *Jawi*, *Saccharum munja*, *kotah*,
Nari (*Arundo donax*)

Herbs. *Salvia* (2 species). *Astragalus*, *Ferula oopoda* two species, one with large tubular, flower stems, numerous compositae, umbelliferae etc. *Artemisia brevifolia*, *Men'ha vulgaris*, rhubarb etc. Near the stream there are nepeta and the greater mullein, Willows and *Sarkana* grass, and various fodder grasses, thistles plantains, eremurus, *Salvia hydruncea*, cynoglossum dandelion.

8-5-1944 From Quetta to Nushki. Rainfall 10½" decreasing to at Nushki elevation 8000'. From 8 miles to 20 miles on way to plains the cultivation to the south is unirrigated, and water is conserved by means of terracing and bunding, without which it is impossible to grow cereal crops on unirrigated land. The hills to the north are barren overgrazed southern slopes, which often are precipitous. That they once were covered with vegetation is proved both by tradition and by the natural cover on the Hazarganji reserve, of which a separate description has been given. Attempts to afforest the Ohltan reserve have been abandoned as both costly and ineffectual.

There is evidently considerable erosion after rain as watercourses, dry except after storms, reach the road, which is protected by earth or stone embankments.

Kalat State In the Kalat State from mile 13 onwards the limestone hills are very bare and the dry watercourses become broader and more stony. The plain itself appears to be very stony, but that is superficial, as underneath the surface the soil is good loam. The reason for the excess of stones in the superficial layer is the removal by the action of rain water of the lighter constituents of the soil, the stones being left behind. The plateau is grazed heavily as well as the hills, and the small bushes or plants consist of xerophytic species of *Sophora griffithii*, *Alhagi camelorum*, *Artemisia brevifolia*, *Withania coagulans* and their associates. There is a very little terraced and embanked cultivation; sometimes the fields have been properly levelled, but no provision has been made for drainage, and the embankments have been broken in the infrequent but heavy thunderstorms; this breaking of the bunds by storm water was very noticeable when I came along the main valley on 2nd May from the Bolan pass.

I am told that that the land is ploughed only once or twice after rain in the winter which is sufficient, as for proper dry cultivation elsewhere it is

customary to plough repeatedly, once after each fall of rain. There is a very sparse population, no trees are left on the hills and the numerous coolies employed on the roads are burning *Caragana* and *Artemisia* bushes as fuel.

Further to the west the soil becomes more sandy and the plateau more barren with more signs of erosion. The hills are very bare. There is a good deal of "*Khushkaba*" cultivation (unirrigated). The fields are terraced and embankments have been broken at places by this year's rain. The crops of wheat are very thin and the stalks are only from one to two feet in height (Kanak height 5,174'). The villagers have made no field drains, nor do they appear to bring the water from the hill slopes to the cultivated fields by means of surface drains. A Sheikhwasil village there is a little water in the river. *Withania coagulans* and very thin and short grass from the main species of a very scanty flora. The weed *harmal* (*Peganum harmala*) is found along the roadside.

The road then runs parallel to a small stream in the bed of which are *Tamarisk dioica* bushes, cut for fuel. The limestone hills are extremely barren, but even here are widely separated *Withania* and much browsed plants that would improve on closure to grazing (*Alhagi camelorum*, *berberis*, *Sarkana* very thin grass etc.).

Then follow wide uninhabited plains covered with thin bushes of *Artemisia brevifolia*, *Haloxylon griffithii*, widely separated one from another. After rain thin grass and small herbs come up only to flower and wither very quickly. At mile 36½ from Nushki there is a small river bed, with some water in it and for the next 3 miles the road is under repair, having been breached in several places by the winter and spring rains as the culverts were too small to take the excessive quantity of storm water. Between miles 34 and 38 from Nushki the embankments of the field are substantial and yet they have been breached by the floods. It is strange to see "dust devils" whirling on either side. Much of the country is true desert with only scanty spiny plants and *Withania coagulans*. At mile 32 there is a village with large level embanked fields and the best wheat we have seen lately, but the embankments have been broken by flood water.

At mile 71 from Quetta the road touches the Kaiser reserved forest. Elevation 4,900', to 6,260' area 220 square miles which was reserved in 1940 but has not been closed to grazing, formed of indurated sandstone rocks with veins of calcite, with very little soil and the thinnest of plant cover. The strata are bent and twisted in every direction by the forces which raised the hills in tectonic movements. The small bushes, never more than a foot in height, are heavily browsed and consist of *Artemisia*, *Haloxylon* and thorny plants widely separated one from another. There is a fair quantity of grass (sila) *Kotah*, *Javi* and *Khavi* growing in isolated tufts to a height of 9" to 18". *Prunus eburnea* is present as a much browsed bush. Rubbarb etc.

There were water, oleander and *pilchi* bushes in the *unllah* at the foot of the hill. Road completely broken at 5 or 6 places a few miles to west of Galangur by floods from the barren hills, numerous culverts exist, bridges have been built to pass the floods down.

10-5-1944

From Nushki across the bed of the Kaiser river with little water, which fans out on reaching the plain rather like *cho* in Hoshiarpur. Its waters are led on to wheat fields and held up by embankments. There are *Rhazya stricta* bushes and little else. Further on on the edge of the plain and below the hills the stony gently sloping plain carries a very thin stocking of *Artemisia*, *Rhazya stricta*, *Haloxylon*

griffithii, *Pynocycla aucheriana*, small bushes, *Pennisetum dichotomum* grass, some chimney grass (*Eleusine flagellifera*) and small dry grasses only a few inches in height, and some minute herbs belonging to *Compositae* & *Cruciferae*. There were rain storms in the winter and spring which accounts for the quantity of minute grasses.

The country is very thinly populated and cultivation depends on (a) storm water from the torrents which occasionally comes down in spate from the hills (b) *karez* under ground artificial channels. There was water still in the bed of *kullah* which had flooded in the winter and broken the bunds of embanked fields.

Fuel. At Ahmedwal railway station there is a firewood dump of about 1,500 maunds formed of the roots of the *Taghaz* (*Haloxylon ammodendron*) a dwarf tree.

From the few shoots and branches it seems that the trees have been lopped for firewood by desert tribes for the year past. From the annual rings on the root stocks many of the trees were over 200 years of age. It seems to be quite wrong to rob the desert of fuel for the sake of the towns, and I understand that the Forest Officer has quite rightly asked for the export of the wood to be prohibited. Later on bush like *taghaz* coppice was seen 4' high, with very thick roots. Further to the west a few small trees of *Stockia brahucica* and small Bushes of *ephedra* sp., *Periploca aphylla* were seen. The bushes are browsed—are about 3' in height. From the abundant signs of surface erosion it is evident that there has recently been a heavy fall of rain when the desert was covered with water one of the periodical thunderstorms which occur at wide intervals. 3 herds of 250 sheep and goats each were grazing. I am strongly of opinion that the immense amount of surface erosion after the last heavy rain is due to the destruction of the natural vegetation by excessively heavy grazing and browsing. There are villages in the main valley which may account for the very heavy grazing. The whole tract should be protected forest, closed in rotation. To the South are very rugged steep hills of volcanic trap with the usual species, and everywhere there has been heavy grazing. Severe surface erosion continued for some miles until the fields of *Mahl ilagua* were reached where thin wheat is grown without irrigation and there are a fair number of old *tantrisk annulatu* trees, the soil being a stiff clay. There is a well at Shakan which is 50' in depth. A fairly extensive area of wheat fields and follows is well embanked in order to catch and retain the water. Further on the soil becomes more sandy and the vegetation consists of *Salsola* spp. bushes and *eragrostis* grass in addition to *haloxylon* and clumps of *Pennisetum dichotomum* etc. *Jawan*, (*Alhagi camalorum*) a Punjab weed, a plentiful. *Andropogon annulatus*; a grass with tough long leave is common. There is a little *Saccharum ellizac* grass (a variety of *s. munja*). Each bush grows on a heap of sand, the intervening spaces having been eroded by wind, "dust devils" dancing over the desert in the distance. At Nagarkot there is good deal of coarse *ephedra*. There are large stretches of *Sarkana* grass, while a large expanse of barren salt land occupied the main valley. At Chandram from where we returned there is a good deal of *taghaz* *Haloxylon* coppice amongst *Caligonum comasum*, *Pennisetum dichotomum*, *Astragalus hyrcanus*, *Pynocycla aucheriana*, and *Salsola arbuscula* and the soil is sandy, which was driven in our faces by a N. W. wind. The small grass *Penacynn-eltactum* helps to hold the sand in place; so does a grass about 2'-3" high, *Stipa pennata*, which grows in clumps on the sides of the dunes, which some times are 100 to 200 feet in height above the plain. There is also some *Chimber* grass (*Eleusine Flagellifera*). If the *taghaz* trees were dug by the roots for fuel the sand dunes would advance. A large encampment had recently been deserted after the camels and goats more or less exhausted the fodder.

11-5-1944 To Kishinghi by road for 8 miles on the way to Quetta and then by camel to north into the Kaiser forest. Kishinghi fields contains quire good wheat. When rain falls in the neighbouring hills it is allowed to collect behind 'walls' earth embankments along the contour in order to moisten the earth of the fields. All that is wanted is a more perfect levelling of the fields and stone escape for excess storm water. As it is, the banks have been broken in the winter rains.

The hills are of gentle slope consist of sandstone rocks shales and detritus lightly covered with small herbs of which the principals species is *Artemisia brevifolia*, all much grazed and thinly stocked, with the earth showing bare between the widely spaced plants.

The run off after occasional storm is considerable. At Ziarates 4,000' the valley had been blocked by a series of dams, of which the largest was 12 feet in height with a base of 40 feet, and behind these dams silt had collected and arable fields were formed over 8 acres and were cultivated for many years. They have recently been broken in the last winter rains, and rebuilt again, and more silt now collects behind them but the fields will never be safe until the catchment area is under control. There are 2 very fine *Khanjak* trees and some tamarisk.

Crossed the Kaiser river at 4,000' where there is most pleasant oasis of tamarisk bushes up to 15' in height on an alluvial plain. Last winter a high flood occured and out channels to the trees. The area is about 500 acres and is very densely stocked. It should be managed on a 20 years rotation as coppice, 1/20th being felled each year and the remainder thinned once every 5 years. The yield would be used for firewood, small ballies and for wicker work. At Simbgur there is a broad valley which has been blocked by large earthen dams behind which silt collected and wheat was grown for some years. They have been broken at intervals by floods, much damage having been done last winter.

In several different valleys, in all of which grazing was heavy, dwarf bushes of *Artemisia* were characteristic of the vegetation with other thorn bushes, and xerophytic plants, the exiguous remains of a scanty flora. The catchment area is in thoroughly bad order, floods in the *mullah* have done much damage to embanked fields, and if at any time the rainfall happens to be heavy floods will occur suddenly and with violence.

The only possibility of regulating the water of the Kaiser river in order to give water to the fields in the lower portion of its course would be the closure of the catchment area. If this cannot be done then partial closure of the area on a 2 year closed 1 years open basis might be tried, but it would be necessary to reduce the size of the flocks as far too many animals graze here. The way back lay through broad cultivated valleys in which fields had been created behind embankments by great labour and a long continued deposit of silt. Many embankments had been broken in the winter rains and it will take many years to replace the soil which has been lost by erosion. Near the road and railway towards Nushki the usual species are present in a very debased form, *Artemisia*, *Pycnogonum*, *Holoxylon*, *Rhazya stricta*, *Stockia brahuica* etc. In the river bed tamarisk is endeavouring to establish itself, but has no chance as it is grazed down at once. With protection, the river banks would support a crop of tamarisk which would help with the local fuel supply. There is a good deal of *sarkana* grass (*S. ciliaris*) near Galangur Railway station, which must be of use to villagers.

Road breaches and broken field embankments in upland plains of Kalat State are frequent.

12-5-1944
Returned to Quetta.

The stream flowing through Sheikh Wasil gorge had been in flood last night and was running full of silt. There is much small tamarisk which is now being browsed by a large herd of camels, and has no chance to grow to any size.

15-5-1944.

From Quetta to Ziarat 68 miles. As far as mile 18 the route had been traversed on 5th May. The valley is very badly overgrazed and eroded. Many donkeys were carrying loads of bushes dug up by the roots with the help of pick axes. Juniper trees have managed to survive very occasionally on the east of valley, which should be closed to all grazing and removal of forest produce. There was water in the side nullahs, as recently there has been heavy rain. The head of the valley was crossed at mile 18, where erosion is very severe and the slopes are bare owing to very heavy grazing. The next valley is open and barren with a very thin and sparse covering of dwarf *Artemisia*, *Caragana* and *Sophora*. Overgrazing and browsing have ruined the hill pastures. Closure is the only possible cure for erosion, and without it there will never be any possibility of recovery. The valley is floored with clay and limestone rocks, which are frequently completely barren or clothed with some *Artemisia*, *Caragana* and *Sophora* bushes and a very few dwarf *Juniper* and *tamarisk*. It rained and the road was dangerously slippery. The scenery was desolate and unpromising in the extreme, and there is no doubt whatever that conditions have become much worse in the last twenty years.

We crossed the Kaoh nala which was in slight flood. The bed is full of *tamarisk* which is much browsed. The fields are well terraced. The hills are bleak and carry only a very few *Artemisia* plants and small bushes. Gradually the vegetation of the valley improves, but the high limestone hills are still very bare: some old mutilated *Juniper* appear and the soil is better covered with *Artemisia* and *Caragana* bushes at Wam Kotal, where the watershed is crossed at 7,616. The Inspector General of Forests in 1940 suggested that the whole valley should be reserved to form 160 square miles of forest. Grazing is heavy and reservation will not be easy. A protected forest would be sufficient provided that at least 1/3rd be closed permanently at high levels and that grazing be rotated in the remaining 2/3rds. This would avoid the difficulty of fixing the rights permanently and might, if necessary, precede reservation, without prejudicing it in any way later on. There is a heavy demand for *Juniper* poles, but as each tree is at distance from its neighbours that demand cannot be met. There were illicit fellings two years ago for firewood here and below Pil reserved forest which have done harm. The best that can now be done is to issue permits for branches and shoots for building timber.

~~Pil~~ reserved forest. Elevation-7500'-9000'. Area-1280 acres. Situated on north east slope above Wam fields on steep slopes with limestone rocks. Fairly well stocked with *Juniper* trees, many of them top dry. Young seedlings are scarce but were actually discovered. There is a fair stock of bushes—*Prunus spinosa*, *Caragana*, *ephedra*, *Ribes orientale* etc. *Eremurus* was in blossom. The soil has been retained in place and there is no avoidable erosion. At Wam village fields have been formed by diverting the silt laden current, and are irrigated. The undermarked scrub forest near the road and elsewhere is heavily overgrazed. Rain fell and the nullahs ran at once with water containing thick silt. Further on towards Kahn village erosion is very severe and the whole country is

overgrazed. There are fine terraced fields. The open valley leading up to Ziarat is bordered by massive limestone hills, whose bare surface is relieved by widely scattered *Juniper* trees, until towards Ziarat *Juniper* is common both on the hills and on the valleys.

17-5-1944. Zargat Reserved forest. Area 2,760 acres not divided into compartments. Elevation 7,740 to 9,270 feet. Underlying rock massive limestone, often exposed on slopes and ridges, elsewhere covered with small boulders with a fair amount of soil. Reserved and closed to grazing in 1890. It was formerly customary to issue permits for grazing all animals on payment of fees, but this has been stopped by the present forest officer. There is an open crop of old, and frequently top dry, *Juniper* which are branched to the ground. There is a very little regeneration and some quite small seedlings were seen, but there are insufficient young saplings and trees to replace the old crop within any reasonable period. There are a few ash (*Fraxinus xanthoxyloides*) some almond (*Prunus eburnea*) bushes, *Spiraea brahmica*, *Caragana*, *Astragalus*, *Daphne oleoides*. Seed of *Prunus eburnea* sown over a generation ago has at one place given rise to bushes which are about 5 feet in height. The *ephedra* bushes grow best under the shade of the *Juniper*. There is much thyme, many *eremurus* and *Mornia persica* plants scattered tufts of grass and minor herbs which give a partial covering to the soil, grass, like *ephedra* seems to grow best under the shade of the *Juniper*, where earth has accumulated. The *ephedra* has been only partially exploited owing to labour difficulties. It is customary to harvest it only when the sap is down from October 15th to March 31st. Snow interferes with collection.

It was interesting to see the effect of stone check dams built over a generation ago; probably when the forest was first reserved. They have arrested a fair amount of silt but not enough to fill them, which shows that little erosion has taken place in the part of the forest immediately above them where there is a fair soil covering of herbs and plants; generally however there has been much surface soil lost by erosion except where there is sufficient protection afforded by *Juniper* trees, bushes, grass and herbs. The roots of some of the *Juniper* trees have been exposed by the removal of the soil, and in the open much soil has been lost. I saw dropping of horses, donkeys, camels and goats, none of them recent, and I am of opinion that in the past closures has been more nominal than real. No animals should be permitted to enter the forest, even to carry wood and *ephedra*, and if any permission for such transport be given the animals should be tethered along the roads and not allowed to graze.

18-5-1944, Batairgi Reserved Forest. Area 7,860 acres, elevation 8,000' to 10,144'. On limestone cliffs and a rolling upland on the north east side of the Ziarat valley. Reserved in 1904 and closed to grazing. In 1910 the western half was opened to all grazing and nomads have established camps in the forest. At times permits have been issued for grazing in the closed portion of the forest. The open portion is thinly stocked with *Juniper* with open stony glades in which there has been much surface erosion. Each old *Juniper* tree stands on a small platform of earth and humus which shows the former ground level. A flood 12 feet in depth came down the nullah last winter. The closed portion is in somewhat better condition in that there is some covering on the soil. At Bano there is some excellent cultivation with a pipe from springs up the hill and pea fields which are irrigated by flood water after rain. The fields have been formed by diverting silt laden water so that it is deposited behind high stone walls and the soil is very fertile.

The nullah came down in heavy spate last winter, but did no damaged to the fields whose situation is precarious. Beyond Bano the hill is steep and the

Junipers are old and scattered. There is very little vegetation, a few *Prunus eburnea* and Juniper bushes having survived the effects of heavy goat and sheep grazing. The rocks are everywhere exposed, and that a great deal of soil has been lost by surface erosion the exposed dry roots of the old Junipers testify. Each of these old trees is helping to hold up the rocks but when they go nothing will be left to prevent avalanches and floods. The forest has been ruined by the pernicious, voracious, destructive goat, whose ability to destroy is equalled only by his fecundity. Near the top of the hill the slope is more gentle and there still are bushes, herbs and some soil. From the top of the hill the view of Khalifat and the Ziarat valley is very fine. On the right of the valley there is much obvious erosion. The floods have become more violent in the past few years, as is proved by the way in which Juniper trees still stand in the stony beds of the nullahs, which obviously at one time were quite small channels, able to drain away the moderate volume of water which came from the forest in the infrequent storms.

The whole valley should be formed into protected forest and either the goats and sheep should be got rid of or the grazing should be controlled. The grazing grounds should be closed in rotation and the numbers of animals should be limited to those which the vegetation can support. Had this policy been adopted 50 years ago the problem of soil erosion would have been far less acute. Across upland down with spiny *acantholimon*, *Astragalus*, thyme and very old Juniper to Gurgut Warg. Rocks have everywhere been laid bare by sheet erosion. Opposite are the Yaya, Kasa hills on which there is much Juniper which might be reserved as forest,

The return journey lay through the closed portion of the Batsirgi Reserved forest. In 1926 I found that protection in all closed reserves had been excellent; but this forest has suffered from very heavy goat grazing, as for some years, and in fact until 2 years ago, it has been customary to allow grazing on permits. Some thousands of sheep and goats, belonging not only to local graziers but to nomads, *powindas*, with no rights, whatever come from far distances to graze here. Years of strict closure to grazing and browsing are now required to restore the ground flora,

20-5-1944. To Shaidan Reserve forest with Mr. Bond, to see pyrethrum broadcast sowings in old cultivation at 8,500' attitude. Rainfall probably 12". Forest is Juniper—*Prunus eburnea*—*sphaera*—*Artemisia*—*eremurus*—grass, thyme, *Morina*—association. Plot—where pyrethrum was sown was thinly covered with dwarf *artemisia maritima*. Results nil.

The Forest Officer will arrange to plant in August 5,000 pyrethrum plants on raised beds at two spots selected by Mr. Bond.

PLOT (a) in *Morina* association.

PLOT (b) in *Artemisia* association.

The object is to see if pyrethrum will grow without irrigation where the rainfall is greatest in Baluchistan.

Permits were issued for grazing up to 1941 from the effects of which it will take long for the forest to recover. The *qazaras* are in a much worse state as the soil has completely disappeared from most of the area old Juniper stand on bare rock.

Back through Zargat Reserved Forest. On steep limestone hills, Juniper of various ages, mostly old, with a good deal of fallen dead wood in

the more remote parts, which is collected for the Ziarat fuel supply. As usual permits had been issued in the past to graze all animals. Up to date permits are issued for animals carrying firewood to graze in the forest while wood is collected. This permission has been much abused, and no animals should be taken from the road which traverses this forest. The remote forests are still in fair order, but the more accessible portions are overgrazed and much surface soil has been lost by erosion.

All reserved forests near Ziarat were properly protected when I last saw them in 1925, but for some years past and until 1942 they have been overgrazed.

To Batsirgi Reserve Forest, seen on 19th May also.

21-5-1944 The Mission Workshops took dry Juniper in 1943 for making pencils. They have now been given a permit for 8 lorry loads of wood. The trees were not hammer marked as no hammers were in stock, and the Forest Officer has ordered some but they have not been received. It is essential that every stump shall be marked, otherwise no possible control can be effective.

The stumps are cut at about 2 feet from the ground which wastes the best part of the tree. All trees in this forest are badly branched, and only short logs of the straightest trees can be of use for making pencil slats. The logs are cut with an axe instead of with a saw, which is wasteful. Control is exercised at the octroi stations and payment is by weight, as there recorded, formerly at -/2/- per maund, now -/4/-.

At Saleh Sakhobi there are fields to which is attached the right to graze 31 sheep and goats, at -/1/- per head each, annual payment of tirmi, over 640 acres. We met two herds, the first with about 70 animals, the second with 30. The animals graze mostly in the lower parts of the valley which are bare and eroded, but they wander over the whole area. An incidence of 31 animals for 640 acres shows what the Settlement officer's assessment of what area was necessary per goat viz. 20 acres: the state of the catchment area and to-day's evidence shows that far more animals have been kept: possibly after correcting the record of rights, which should be verified.

At Kalalandi are the remains of Moghul fort: it is doubtful if one could be supported here now. There are very fine terraced fields at Saleh Sakhobi, where every drop of spring water is utilised, and even then there is enough water for only one quarter of the area at one time.

Gohar Reserve Forest. Seen on 15th with P. A. and on 22nd May.

22-5-1944.

A forest reserve on both sides of a steep valley of limestone rocks on which is juniper forest, in which the majority of the trees are very old. There is a disproportionately small number of saplings and young juniper trees. The forest on the N. W. slope is very much better stocked than that on the S. E. slope, where many of the old trees are half dry and stag-headed. There is a fair quantity of ash trees and bushes, *prunus*, *spiraea*, *berberis*, etc. in the portion closed to grazing rights, but in the last mile below the ridge where villagers have rights to graze there is very little ground cover.

The M. E. S. have made check dams to hold up the rainwater along the *nalluh* bed, which are apparently of some little use, as when seen on 15th after rain they were either moist or contained a little water.

Photo 3. Much grazed *guzara* at Tsat hill, Gohar, Juniper and spiny bushes, characteristic of the locality, altitude 10,000, some grass and *spiraea* in crevices in the rocks.

Photo No 2 shows Shinshobi peak with Sarakhezi *guzara* which is suggested for reservation. The upper portions consist of limestone sheet rock from which the surface soil has disappeared, but it persists on slopes to the south and in the lower portions. The Juniper trees, much browsed bushes and herbs cling to the cracks in the rocks and to the slopes. This is typical of almost the worst type of *guzara* forest that is proposed for reservation or for closure to grazing in the neighbourhood of Ziarat.

The eroded slopes to the North west of Batsirgi forest are less well covered with trees, but the soil is deep and although it is eroded closure would bring about an increase of bushes, herbs and grasses. Several miles of juniper forest, however degraded, should be demarcated on both sides of the Quetta valley. The present reserves form only islands in a sea of forest that should be protected and managed properly.

Tsat hill 10,248'.

Vegetation. Juniper. Much browsed *Prunus eburnea*, and *catoncaster*, *spiraea*, *thyme*, *cremurus*, *Morina* spiny *acantholimon* bushes (*astragalus*) *caragana* and minute herbs, *viola* etc. in the cracks between the rocks. The Juniper becomes a straggling tree of bush-like habit and sends its roots many yards from the parent stem in search of moisture, each tree being widely separated from its neighbour as is typical of an arid climate.

Back along the Gohar valley along a disused bridle path which is stony and out of repair. In spite of this there has been a good deal of animal traffic. The juniper trees are often very fine for Juniper up to 10 and 11 feet in girth. This valley is quite well wooded and there is a fair amount of shrubs and bushes.

23-5-1944 Ziarat to Chauter forest in Loralai District and back by lorry. The Sibi District extends to the watershed. The road is bordered on the north by the Batsirgi reserved forest, and on south by the Kato *guzara* which is open to all sheep and goats etc. grazing. The *guzara* forest is on steep limestone slopes from many of which the soil has disappeared, but it contains many juniper trees and, if protected from grazing would recover a great deal of its former fertility. It should be demarcated.

Loralai District. To the East of the watershed the road runs through very fine natural scenery with high precipitous limestone cliffs bordering on a broad valley which is covered with fine juniper forest full of tall *caragana*

gerardiana and *berberis* bushes ablaze with golden blossoms, the ground being carpeted with pink and yellow *eremurus* lillies in a green carpet of herbs. A very pleasant change from the forest nearer to Ziarat.

These forests, Karbi Kaoh and Khumak, will be visited and examined in detail later on. However I could not resist the temptation of climbing up to the cliffs to take a photograph of natural untouched forest, when I found numerous signs of recent goat grazing, for which the forest guard should ordinarily be summarily dismissed-explanation week.

Later I was told that until 2 years ago it had been customary to permit grazing each year for one month.

To Chauter forest as far as the spring and the *galli* at 8,255'. A good juniper forest in the lower portions, thinning out on the limestone hills on either side. Usual association of ash, wild almond, *berberis*, *ephedra*, *spiraea*, *lonicera*, *sphora*, *carayana* and a little grass. It has been customary to allow sheep and goat grazing for one month, but as *ephedra* is an important crop and is eaten by goats, no goats should be grazed here. There is a good deal of surface erosion and it would be much better to keep the forest closed to all animals if the villagers consent.

Guzaras.

The whole catchment area of the Bazali Narai Valley consists of thinly stocked, overgrazed juniper forest, and should be demarcated. So should the *guzara* to the south as far as the Loe Ghar peak 10,213' and the valley called Wurlum where there is very heavily grazed and eroding juniper forest with a much-browsed plant association of the species noted in Chauter forest. Also the valley on both sides of Nishpa.

Note—When demarcating the new forests great care should be taken to keep the boundaries two hundred yards from recorded cultivation. Access should be given to springs. Where there are rights of way grazing should be permitted by animals where in transit along the road up to a distance of one chain on each side of the road, even when the forest has been closed to grazing.

I should like the top third of each catchment area or watershed to be closed permanently and the remainder to be open and closed in rotation, and at the same time the flocks should gradually be reduced to the numbers which can graze without destroying the vegetation, if that be possible which I doubt.

It is obvious that at present, throughout the area traversed from and including the Chagai District to Chauter, the flocks are far greater than the vegetation can support. If a permanent reservation of one third be not accepted then the whole should be rotated in order to permit of the vegetation recovering during the period of closure, but this will only be a palliative and not a permanent cure. From what I have seen the ground cover should improve considerably 5 to 10 years, depending on altitude and rainfall and on proximity to cultivation.

Some areas are so heavily eroded that nothing other than permanent closure can afford a cure. The son of Khan Sahib Shahbaz Khan Sardar of the Vansohi tribe which possesses exclusive grazing rights here says that there has been much migration to other regions, the men returning for harvest. He acknowledges that something is radically wrong with the grazing régime of this tract. He volunteered the information that the floods in the stream were now so severe as to harm the *Khushkaba* fields. He suggests the subdivision of the summer pastures, and says that there is ample grazing in the winter near Harnai.

23-5-1944. *Ephedra vulgaris* grows into a bush of considerable size, one measured today being 6' 6" in height, but this is not usual. Where not grazed bushes of 3 to 4 feet in height are common. The goat browses on them, but not for preference, as he prefers other bushes and shrubs. The sheep is said not to eat the *ephedra*.

Ephedra is found commonly under juniper trees, and under bushes rarely in the open, and the reasons appear to be (a) its preference for shade (b) the infertile nature of the open glades from which the top-soil has been lost by soil erosion. Chaudhri Mohd. Sulaiman Khan, while we were considering the *ephedra*'s habit of growth pulled up some young plants in Chauter forest which appeared to be seedlings and found that the plants were connected with parent plants by underground roots and were themselves throwing out underground shoots (rhizomes) in a manner similar to couch grass, from which fresh plants were produced at the nodes every few inches. He will now arrange for an experimental planting at once as it is most important to discover a cheap and easy method of increasing the stocking of *ephedra* in Baluchistan. Seeds should also be sown when ripe in proper nursery beds, (*ephedra* is now flowering) The bushes were cut heavily in 1941 and by next autumn will have had 3 years' rest and have grown well and are ready to be cut again. Goat grazing is very injurious to the growth of *ephedra* for drugs and no grazing should be allowed in a forest about to be harvested. An interval of 2 years between cutting is essential: 3 would probably be better.

25-5-1944. Karbi Kach reserved forest.

Part was seen on 23rd—vide notes.

The part now seen near the Kotai pass on the Ziarat-Harnai road was in much worse condition, having been grazed in the past.

The ash, wild almond, *caragana*, *lonicera*, *spiraea*, *berberis*, *ephedra*, *cotoneaster*, briar rose, cherry etc. bushes have all been browsed, there is little herbage, chiefly thyme, *acantholimon*, spiny *astragalus* and *morina* which are not liked by cattle. Also *cremurus* lilies, *artemisia* etc.

The forest, however, is generally in better order than those nearer to Ziarat and parts of it are well stocked. There are top dry Juniper trees, but not many dead trees of quality suitable for pencils. There is a fair quantity of *ephedra*, last cut in 1941, and some of the bushes have sprouted sufficiently to be cut again, but many have been so browsed as to be unfit to yield a crop of twigs for distillation.

At Chauter is a reserved forest, the interior of which was seen and described on 23rd May. The lower slopes are quite densely covered with Juniper: the upper portions are very rocky but bushes and some Juniper persist wherever they can find a foothold in the crevices of the rocks. The *guzara* forest is in much worse condition, being heavily grazed while the Juniper trees are lopped and mutilated for fencing and rafters. For some miles the *guzara* forests contain scattered and much mutilated juniper, the soil covering consisting of much browsed almond *berberis* and *caragana* bushes with *artemisia*. *Withania coagulans*, *Mentha sylvestris* and *Sophora griffithii*. The country is dry and vegetation more sparse. The river bed is broad and stony with several channels. After crossing the stream bed the country has a barren appearance but there is a good deal of closely grazed grass and scattered spiny bushes of *convolvulus*, *acantholimon*, *artemisia* and a very few *caragana*. The hills on both sides of the very open valley from mile 3 towards Harnai appear from a distance to be very bare, but there is nevertheless some low vegetation. Even here rotational closures would permit the grass to spread. A little further on the coarse tufted grass is much more plentiful, the reason being that there is no water for stock.

Cultivated fields in a *nullah* bed had been very cleverly built with silt, irrigated by a channel in floods on the right bank, with an ample escape for storm water along the left bank.

At Zindapir levy tower 22 miles to Harnai, there is a gorge with scattered, looped and pollarded ancient olive trees. The forest has disappeared and erosion is as bad as it can be on these hills of limestone detritus. Dilkuna reserve has been closed for 40 years. It is practically a blank hill side with a few scattered olive trees over 60 acres hardly distinguishable from the surrounding waste when one is at a distance, but on climbing up above the levy tower is found to be in much better order. There is plenty of grass (*Cymbopogon jwarancusa*) and the olive trees, which evidently had been heavily pollarded 50 years ago, have grown.

Evidently in ancient times these valleys were covered with olive forest now they are eroded wastes and rock slides. There was a good deal of goat droppings, in the portion inspected.

28-5-1944 To Kala Ghowazhi village and back, where there are sulphur springs and fish in the stream. The broad valley above Harnai has a stony floor subject to occasional floods. The most conspicuous features of the thin vegetation are *Rharya stricta* and *Withania coagulans* bushes, dwarf palms, *Acantholimon* plants. There are also much grazed, *Vitex negundo* bushes. *Saccharum munja* (variety of), *spontanum* and coarse fodder grasses. There are rice and wheat fields irrigated by water channels bordered with *shisham*, mulberry, *beri* (*Z-Jujba*) trees and vines. From every mud hut and house goats were emerging as we passed. In the evening discussed with Major Pinhey, O.B.E., the Political Agent, Sibi, with the E. A. C. and with a local Syed the grazing question. The E. A. C. spoke of local grazing customs and agreed that pastures were insufficient and needed closure for rest in rotation. He spoke of Afghan immigrants to winter pastures. He said that local villagers all say that there is less rain now-a-days than in former years. Major Pinhey says that the winter are less severe in that less snow falls. I attribute this to increasing desiccation on account of soil erosion as the water now pours uselessly over the surface of the soil and removes it as it is no longer protected by vegetation which has been far too heavily grazed. The regulation and rotation of the grazing are essential in my opinion.

27-5-1944. To Ziar Tarang at foot of Wam Tangi forest along stony broad valley between low hills formed of pebble beds with some species as noted yesterday. There are many hundreds of acres of *Vitex negundo* coppice which shows the amount of surface water, and probably of underground water in this *nullah*. It is used for roofing and for firewood of poor quality and is only occasionally browsed. There is a little *Saccharum Ciliare*, a good deal of *S. officinarum* grass and *Periploca aphylla* (*bata*) and much, *Cymbopogon Jawarancusa* (*Khavi*) grass. Towards the hills there are scattered *shisham* trees showing still moister conditions, some *Zizyphus* bushes and *Sanatta* (*dodonea viscosa*). With closure it would be possible to increase the *shisham* by cutting the roots which would give fresh shoots: possibly also by stump planting, but this would have first to be tested. This forest might be reserved.

Wam Tangi
reserved forest.

Situated at the foot of the hills in a broad stony valley down which water pours after rain. Elevation 3,600' to 4,100' above sea level. Crop. Scattered *shisham*; *Pistacia* *Kharjuk* and *Kabulica Tecoma undulata*; *Olea cuspidata*; with some *Zizyphus jujuba*; much *Vitex negundo*; a fair amount of *Dodonea viscosa*. much *Periploca aphylla* and *Saccharum ciliare* and *officinarum* and *Cymbopogon* and dwarf palm. In 1942

trees were felled for the Quetta fuel supply, but felling obviously was very slackly supervised, the stumps are very high. Opportunity should have been taken of the demand to cut all mutilated *shisham* and other trees flush with the ground.

The *Shisham* olive, *tecoma*, *beri* trees coppiced, but old *Khunjak* stumps are dead. In July last Ch Mohd Sulaiman Khan found that the coppice shoots were all browsed. He insisted on proper protection from grazing and the forest has since greatly improved. The better *shisham* 2 years old shoots are 8' to 12' in height and root suckers have appeared. It would be as well to plant out *shisham* stumps experimentally in the moister places, using *Vitex negundo* bushes as nurses, as below them there is some earth. Some *Prosopis glandulosa* sowing at the top of the forest were successful some years ago, but the trees are small and bush like. They have given rise to fresh seedlings naturally lower down the nullah bed *Bhabbar* grass (*Eulaliopsis binata*) was found which is used for ropes and, in the Punjab, for paper making. Wam Kach (Wam mean terror) lies at the junction of two nullahs at about 5,500' and is a narrow strip of thinly stocked olive forest on both sides of these nullahs, and main stream. Water is plentiful. Vast stretches of *guzara* surround the forest. Grass (*Cymbopogon jawarancusa* and *Eulaliopsis binata*) grows plentifully. The olive is very old the trees were pollarded before the forest was reserved 50 years ago. There are very few young olive trees. There are a few bushes of *Daphne olivoides* and some dwarf palms. On the left bank are wild grape vines which cover the olives and traditionally are due to a Saint who ordered the vines to remain where they were when they were going to climb the hill. There are no olive trees available for firewood supply of Quetta. The forest has been grazed regularly for part of each year, although it is supposed to be closed. The soil at any rate is protected from the erosion satisfactorily and its condition is much better than in the Dilkuna gorge where grazing has been followed by wholesale erosion of the soil.

28-5-1944, Cilmale.

The climate of Balochistan is one of extremes with severe cold in the winter at high elevations and intense heat in the summer at the lower elevations, particularly in the low foot hills and the plains where shade temperatures, reach 126°F. At higher elevations the day temperatures are high in the summer but the nights are always cool. In the winter the climate is cold and snow falls. Long periods of drought and high winds are particularly unfavourable to vegetation.

Rainfall.

The rainfall, increasing with elevation, shows marked variations, depending on situation throughout the year. Usually the wettest months are January, February and July, followed by long periods of draught which occasionally are broken by storms of tropical intensity when much rain falls in a very few hours. Some statistics of rainfall taken from recent records are of interest:—

Place.	Altitude	Jany 1942	Feby 1942	July 1942	Total.	High daily rain.	
						1942	1944
Sibi Alt: 500'	Normal 1942	1.21	0.53	2.35	4.76	July 2nd 1.54	...
Harnai Alt: 3000'	Normal 1942	0.81 3.30	1.06 3.7	3.07 10.18	13.34 24.09	July 8th 2.12 „ 17th 2.37	......
Lotalai Alt: 4500'	Normal 1942	0.90 1.78	0.95 2.40	1.37 1.21	9.05 8.24	......	......
Fortsandeman Alt: 4700'	Normal 1942	0.60 2.19	0.94 2.39	2.26 3.70	10.95 10.86	July 7th 1.74...	......

Place.	Altitude	Jany 1942	Feb'y 1942	July 1942	Total.	High daily rain.	
						1942	1944
Quetta	Normal	...	...	...	...	...	...
Alt: 5,500'	1942	4 14	1.99	0.84	9.97	...	...
Nushki	Normal	1.39	1.36	0.05	6 03	...	Mar 25th 0.90
Alt: 3000'	1942	2.70	1 51	0 21	8 40	...	...
Dalbandin	Normal	0 82	0.95	0 08	3 72	...	...
	1942	1.21	0 61	0.08	3.45	...	...
Mastung	Normal	0.90	1.08	0.17	6.84	...	Mar 25th 1.40
	1942	5.68	1.81	0.61	14 41	...	Mar 26th 3.17

. Notably high daily rainfall.

			Normal yearly	
Pasni	....	3.07	18-1-39	6 14 (Mekran).
Khost	...	1.75	21-2-39	-8.93
Spintangi	....	1 76	26-2-39	9 41
Sanjawi	...	2.45	22-3-39	10.78
Duki	....	2.12	14-2-39	9.92
Sanzal	...	3.00	26-2-39	10.61
Shahrig	....	2.60	17-7-29	13.21
Gandawa	...	2.75	6-7-41	4.25
Nakas	...	9.00	21-7-41	11.92
Harnai	....	3.04	21-7-41	13.34
Urak	....	1.73	22-1-44	13.26
Mastung	....	3.17	26-3-44	6.84
		2.77	10-1-43	
Kolpur	....	3 00	11-1-43	9.08
Barkhan	...	1.50	7-6-44	...

30-5-1944. Firewood depots at Loralai.

Supply Depot for Army. In stock 10,000 centals. Losses since 1937 4,200 centals, discovered at stock taking on 17-2-44. Should have been checked annually at least. Reserves and stocks that have not been opened should be whitewashed to prevent pilfering. Stocks should be smaller to allow (a) of easy check (b) of safety from fire. The Army demand has doubled and is based on 3 lbs. (at Lahore 2 lbs. has been found to be sufficient and as firewood is not plentiful the Lahore scale might be suggested for basis of calculations at Loralai). For checking stock of 3 cwt. = 1 maund of 82 lbs which is about right for *phulai*, olive and Khanjak of which these stocks consist. Form 5, 6 and 7 written up.

City Depot Used for retail issues @ 1/3 and for receipts from *guzaras* of dry wood @ Re 1/- per maund. Forms properly maintained 10,666 centals in stock on 18-5-1944.

31-5-1944. From Loralai to Gumbaz R. H. 70 miles, via Bhagao (4,400') where there is irrigated cultivation with *Anar*, tobacco, and apricot trees. There is much '*nara*' grass *Arundo donax* in the nullah beds. The country upto date has been barren with dry sunburnt limestone hills on either side of wide valley with scattered shrubs of *Haloxylon*.

Duki, height 3,880' is a scattered patch of cultivation irrigated by *kuhls* on the edges of which are large willow trees and mulberries, with apricot, melon gardens all well walled in.

On the roadside there are many *Prosopis glandulosa* trees which in the tehsil headquarters are spreading, the seeds being eaten by goats and then germinating. There is a good deal of dwarf palm, some *mulla* bushes, but the country is a dreary waste of thinly stocked *haloxylon* shrubs with a good deal of dwarf grass.

Some of the hills are formed of calcareous sandstone. At Manzai there is a dry river bed with *Vitex negundo*, *Zizyphus*, *Tamarisk*, *Tecoma undulata* bushes and a few *karil* trees and *Calotropis procera*, *Wathania coagulans* and *Rhazya stricta* shrubs.

1-8-1944. From Gumbaz to Nawababad along the flood plain of the Narechi river and then half way up the hills to the North and back.

1. The flood plain,

The Narechi river wanders through its flood plain which consists of mud flats covered with *Tamarisk annulatum* trees and *T. dioica* bushes dotted amongst grassy glades, with khabbal (*Oyanodon dactylon*) and palwan (*Dicanthum annulatum*) grasses, with sedges in the damper localities.

Silt is arrested and the bed raised where the grasses have grown, as in the forest reserve, where grazing is only moderately heavy, but outside the reserve the grass is thin and heavily grazed. Most of the old *Tamarisk* trees could be cut. There are some poplar trees (*Populus euphratica*) but no regeneration probably due to grazing. There is a lot of good wheat land, about one quarter of it uncultivated for lack of tenants. The fields are levelled and embanked with the help of the *karrah* and are inundated during the monsoon.

Cattle are numerous and are grazed in the waste and in the reserve for which the rent of 192 acres is Rs. 685/-

The hills are exceedingly rugged and stony, and rocks are everywhere exposed. They consist of sandstones with a proportion of lime and limestones with a proportion of sand.

At one time they must have been covered with thorn scrub forest, as there are still the remains of *Phulai Salvadoria* wild almond and *Daphne*. There is a little grass (*Kotuh*, *Dhaman*, *Chimber* and *Khavi* some *Alhagi camelorum* bushes, with dwarf palms and *Haloxylon* but the soil has been washed away by storm water. There are *mulla* and *Saccharum ciliare* at the bottom of the forest. The Gumbaz reserve is really a grass preserve let annually for Rs. 685/- for cattle grazing. The unclassified forest of 2,500 acres is open to all rights, but the land belongs to Government. Fees are taken from *powinda* for grazing sheep, goats and camels and the right to collect these is sold annually.

3-8-1944. Gumbaz to Ghatipul. At about 3,000' above sea level, Along the edge of a flood plain of the Narechi and Anambar rivers dotted with *Tamarisk annulatum* trees and *T. dioica* bushes, with grass pasture heavily grazed. The trees belong to Government subject to village rights of user.

Many are old and the forest near the hills is disappearing as no longer is it flooded. Browsing is very heavy and is ruining trees. Many Powinda and Marri camels and goats come here in the winter.

4 & 5-8-1944. At Ghatipul. There is a good deal of drift *amarisk* firewood which no one seems to want. The hills are barren, but on closer inspection are seen to contain some *Cupparis* and *Periploca aphylla*. *Zizyphus nummularia* bushes, tufts of *Alhagi camelorum* and very thin grass chiefly *Pennisetum orientale* and various sub-species, and *Eleusine flagellifera*, and various cruciferous small herbs, on which sheep and goats graze. Was joined by Capt. Saker, Political Agent, Loralai. He is of opinion that grazing could be regulated by rotational closures, which could be forced on, if not welcomed by the local people, but did not know what to do with the vast herds of immigrant Marri and Afghan flocks, because of the political implications.

6-8-1944. From Ghatipul to Loralai, leaving the Thal Chotiali flood plain of the Anambar river, with *Tamarisk* and poor grass behind and crossing a waste of *Salsola* plants on dry mud flats and passing the long earthen bund built with the idea of irrigating the plain, but destroyed by floods. At Baghao there is much *nara* (*Arundo donax*) grass owing to the ground being wet with seepage water.

7-8-1944. Saw Col. Searl, Political Agent, Zhob and Mr. Mustafa, Director of Agriculture. Tour changed at latter's request to go through Barkhan to see bunded cultivation and at former's request delayed so as to enable me to meet him at Shinghar.

8-8-1944. To Nargassi 36 miles by lorry and 3 miles on foot and back to Loralai, at first along a wide valley bordered by bare hills. There are two grass reserves, Kohar and Spingwar on the right-not visited but said to be similar to Nargassi reserve.

Nargassi Area 5120 acres, Elevation 6,280' to 7,912'. Underlying rock:—limestone, shale with a fair amount of earth. Slope moderate to steep. Originally formed as a grass reserve, but no grass is out as there are very few cattle, and the Army does not need the reserves as the grass is poor. *Powindas* and villagers were allowed to graze all kinds of animals for 3 months each winter at @ -/1/- per mensem for a sheep or goat, until 1943-44, when the present Forest Officer closed it.

There is much more grass than outside. On the slopes the grasses are *Cymbopogon jwarancusa* (*Khavi*) grass.

In the nullah there is some *euphorbia* (dwarf) much *Sargassi* (*Sacharum Ciliare*) which has greatly slowed down and reduced the run off of storm water. There is some *Tamarisk*. There are a very few *Pistacia Khanjak* and *Kabulica*, some *daphne oleoides*. *Prunus eburnea*, *caraqara gerardiana* and *sophora griffithii* bushes. Also *Pennisetum orientale*, *Cenchrus Ciliaris* grasses. There has been illicit camel browsing.

The following additional plants on the hills were seen very sparsely scattered through the *Khavi* grass which itself consists of widely separated tufts. *Haloxylon* sp. *Astragalus* sp. rhubarb *ephedra*, *Zuz* (*Jawasa in Punjabi*), *harmal*, *Artemisia*, *erumurus*, *Eleusine flagellifera* (*Chimber grass*), *Astragalus*. Most of the rhubarb has been dug up by porcupines. However scanty the flora of the closed area, as described above, the ground cover is much more abundant than in the open grazing grounds, where grazing is very heavy, particularly in the plain near the village. Everywhere on the way to Loralai there has been much surface erosion and the dry bed of the stream is broad and evidently more water comes down now in floods than in former years and this is due to the lack of cover, owing to grazing and browsing in the hills.

In the evening Mr Mustafa, the Director of Agriculture took me to a very fine almond plantation at Martad Khurd 9 miles down the Fort Sandeman road under the hills where water is available for irrigation. Nearby the broad dry nullah is broadening its bed, has already cut into cultivated land and from its ravines extend back into the plains bordering on the orchard. In the last 5 years the ravines have got much closer and soon will reach the garden. They cannot be held in check until grazing is stopped. Two very useful plants grow naturally. *Sarkana* (*Sargassi*) and *Banba* (*Vitex negundo*), which if protected from grazing would choke the nullah beds and put a stop to erosion.

At present sheep are grazing in the waste, where there is a thin cover of *Haloxylon*, *Withania coagulans* and *Rhazya*.

10-8-1944

From Loralai to Bakhlan 146 miles.

The road leads to the south through fertile wheat lands of a vast cultivated plain bordered by distant hills and irrigated from Karez, with walled orchards.

Every field is terraced, with small embankment to retain the water. Only the land in the immediate neighbourhood of the village is manured, and fertility is maintained by following in rotation for one or more years. There are mulberry and willow trees along the water channels.

To the N. W. the main line of drainage is 15' to 20' below the level of the plain and there is a good deal of ravining as noted at Martad Khurd on 8th June. Where uncultivated the vegetation consists of *haloxylon* and *salsolaceous* plants.

In similar country in the Thal plain it is proposed to use tractors. Unless the fields are narrow with not too much difference in level the weight of water in thunder storms will break the peripheral bunds. Cross bunds, (*latts*) will also be needed. In the uncultivated land here there is a good deal of sheet erosion and this will have to be taken into account in the Tractor scheme. A few herds of sheep and goats and a few hundred nomadic camels were seen. By mile 25 the natural vegetation had improved and the country was undulating and less cultivated.

Where there were dry water courses there were *Tamarisk*, *Jawasa*, *Sophora*, *Rhazya stricta*, *Withania*, etc, *Sargassi* grass, *chamber* and *eragrostis* *Khavi* grass etc. On the slopes are *Pennisetum* grasses, *acontholimon* etc. It had rained on 6th and 7th and there has been much surface erosion. The water was tapped partly by an inundation channel. The country becomes hilly, stony and unprepossessing until at Tohr there is a village and wheat fields irrigated from a spring. We rode ponies 6 to 8 miles towards the South to Gadebar reserved forest on limestone rocks elevation 4,500' to 6,600' and lying on both sides of a long ridge. The Northern face is covered with tufts of *Khavi* grass (*Cymbopogon Jawarancusa*) and dotted with trees of *phulai* (*Acacia modesta*) much lopped olive and *Khanjak* (*Pistacia Khanjak*), also lopped. There are a few *daphne* and *Periploca* *phylla* and *ephedra* bushes. The nullah evidently came down in spate last winter.

It has been customary to let this forest to *Powindas* for grazing sheep, goats, camels and donkeys each year until April last for winter grazing for 3½ months. The lower slopes are grazed quite heavily. Nevertheless the forest is in better order than the surrounding waste.

The forest lies in the Honawar (Anambar) valley, the Northern slope in the *Bori* and the Southern slope in the *Duki* tehsil.

The still are some *phulai*, *tecoma* and *Zizyphus* trees on the gentle slopes outside the boundaries but there is no regeneration either outside or inside the forest. The sloping plain below the hill is stony, dotted with tufts of grass and with *Chimber* grass endeavouring to spread its tendrils over the stones in spite of the grazing. There are browsed *bata* bushes *Periploca aphylla*) and spiny *alhagi camelorum*, *harmal*, *acantholimon* bushes and very little grass. A most depressing flora, and yet this plain is traversed by deep steep sided ravines which, invisible a few yards away, are filled with olive and *khanjak trees*, and as the *nullahs* broaden *Zizyphus*, *phulai*, *sophora* and *sargassi* grass. Nature does its best to check erosion by choking the *nullahs* and ravines with vegetation which men sheep and goats and camels hasten to destroy. An amazingly callous outlook which cares not a jot for the future. The trees are lopped, browsed and mutilated, there is no regeneration and the countryside is doomed unless a different regime is adopted.

10-8-1944. On way between Loralai and Barkhan.

Riokter guzara. At mile 53 the road climbs into the hills. There are scanty remains of an olive and *phulai* forest but no seedlings at all. The tufted *khavi* grass is heavily grazed. There are the usual spiny *alhagi camelorum* and *periploca aphylla* bushes. The grazing is good and old grass is burnt in winter and spring.

From mile 68 onwards the road runs through hills on which there are very sparsely scattered *phulai* trees. The rains of 6th and 7th June had swilled the surface soil over the road and this has just been cleared. Everywhere as far as the Kajuri levy post, some miles ahead, there has been recent erosion of the top soil, the vegetative covering having been ruined by over grazing. My clerk calls the country not Baluchistan but *Kabristan* and this is prophetic.

For miles and miles the Roads leads through the hills which are dotted with *phulai*, bush like trees, much browsed and mutilated olive, with *Zizyphus sophora* and dwarf palms in the valleys. The whole place is overgrazed and eroded and has a most depressing effect on ones spirits. From the Kingri levy post the hills are in a bad state. Some good *khushkaba* cultivation is passed where wheat is being threshed and then from mile 100 onwards there are limestone hills on the left with *phulai* and some olive, all heavily grazed. For some mile along this road the forest should be demarcated and protected.

11-8-1944. At Barkhan.

Visited the fields of the Haji Kot, Char Kot and Mir Haveli villages with Mr. Afridi A. P. A.

A most interesting morning, meeting the owners who cultivate the fields, themselves.

Factors of the locality. Elevation 3,650'. Summer day temperatures high nightschool.

Rainfall. Subject to sudden storms as for instance on 6th June 1944 when 1½ inches of rain fell in 3/4 of an hour.

Soil. In the background are limestone ridges almost completely bare of bushes and of soil in front of which are stony slopes leading down to gently sloping alluvial etc., loam soils (with a good proportion of clay) traversed by the Dhaura dry stony stream bed.

The Dhuala river. After rain the river comes down in high spate, and from the way in which it is cutting into its banks and from the general appearance of the stream bed I am of opinion that the floods are of greater violence now than in former years.

The flood waters are utilised in irrigation canals which inundate level embanked terraced fields. Dams are made and constantly broken. There is an elaborate system of water distribution.

Tradition says that the arable area is now only 40% of that which at one time existed, but I doubt if this is correct. There has certainly been some considerable reduction in the arable land owing to flood action.

The Haji Kot & Chur Kot Sailaba fields. The bunds are very fine, often 10 feet and more in height with very broad bases. Some individual fields are of over 20 acres. They are cultivated for wheat in alternate rotation with *Jawar*, or wheat after wheat. Some of the bunds have been broken in the spring floods, sometimes undermined by rats, or broken by the weight of flood water which had not been able to get down the escapes, which have no regulators.

Some of the bunds are half a mile long and of great height and breadth and one individual field was of 20 to 25 acres: it is said that some are of 50 acres. A pair of bullocks is said to be needed for 8 to 12 acres. There is a shortage of bullock power and ploughing is done twice when the soil is moist, once for sowing and then the field is harrowed.

The Mir Haveli Khushkaba fields. The water which flows from the limestone hills behind the village is most carefully conducted to individual fields formed in level terraces behind long high and broad bunds, called *latts*, a channel running along the foot of the hill immediately in front of the village with off-shoots leading to individual field, and allowed to go from one to another by escapes.

The distribution of the water between the owners is according to a regular scheme. Rats have undermined the bank in many places and water has poured on to the fields below. I think bunds have also been broken because of the lack of proper means of regulating the use of escapes. The whole assembly of fields was an instructive lesson in land management and water use. 3 earthen dams block the Doriawal valley between limestone hills.

The lower was commenced in 1935.

„ middle „ „ in 1941.

„ upper has not been finished

The Gundah bund. Length about 300 yards: Height 20 to 25 feet. Built in 1935 to 1941 and burst when $1\frac{1}{2}$ " rain fell in $\frac{1}{4}$ of an hour on night of 6th/7th June, 1944. They will be repaired. The run off of these apparently barren hills is extremely rapid. When examining the surface closely there is seen to be a good many grass clumps, are very closely grazed, some *halorylon* bushes, a fair quantity of *phuldi* and some quite young *phuali* bushes. *Capparis aphylla* and spiny plants etc. and occasional dwarf palm in the valleys. If not continually grazed these would be scrub and bushes which would moderate the violence of the floods.

16th & 17th-8-1944. *Shinghar Forest.* About 4 square miles have recently been notified as reserved forest and will be closed to grazing. Seen with Col. Searl, Political Agent on 16th and again on 17th. I went up the ridge to beyond the trigonometrical point: a troublesome ascent through cliffs, Rock-calcareous sandstones and shales.

Crop. Old overmature and many dead *Pinus gerardiana* trees. Many years ago part of this forest was burnt which accounts for numbers of dead trees. Old age accounts for many more. At one time it was thought that death was due to insects and some trees were felled. There are few young trees due to over grazing. Such young saplings as are found are in the midst of bushes which have protected the young seedlings from browsing. At the top there are bushes and some grass and herbs but lower down the soil is very bare:

Fraxinus canthoxyloides-ash *Pistacia khanyak*, *Prunus eburnea*, (wild almond) *Daphne oleoides*, *Cotoneaster*, *Ephedra vulgaris*, *Caragana gerardiana*, *Buddleia paniculata*, *Sophora griffithii*, *Plectranthus rugosus*, *Astragalus* spp. *Rosa*, (briar rose), *Berberis vulgaris*, *Olema*, *Ferula oopoda*, *Verbascum erianthum*-(mullein), *Campion Thyme*, *Pennisetum*, *Melica jacquemontii* grass, which is poisonous to animals, and other grasses.

An attempt, instigated by Col. Searl was made last year to secure regeneration artificially. Some seedlings have survived under bushes. Sowings should be done before snowfall of isolated seeds on the northern side of bushes, and patches should be well dug and seed sown also under the shade of bushes, the surface of the patches conforming to the slope of the hill so as to be well drained without being water-logged.

The numbers of species mentioned show that originally the hills were densely covered with vegetation. The forest is now in its last stage and is doomed unless closure and continued sowing manage to restore it.

This is worth trying but the sowings will not succeed unless carefully supervised.

On either side of the Shinghar ridge and far below are vast stretches of much eroded hills where grey shales are exposed and on them survive scattered olive trees and patches of bush-like ash, the sole remains of very extensive olive forests. The olive trees are of an immense age and nearly all have been pollarded, or are mere bushes which have been browsed year by year. Some stand in the broad beds of stony *Nullahs*. The ground covering has vanished and the whole of the lower hills are scoured with channels and vast quantities of soil has been carried away by storm water.

The country has been ruined by deforestation and is doomed. The higher slopes still have a little cover but are in a thoroughly bad state.

18-8-1944. Pasta-Haripal forest lies on bare shales at the foot of the Shinghar hill and is quite well stocked with ancient pollard olive, ash and *khanyak* trees, and very heavily grazed and eroded. There are wide stony torrent beds where once there was, a proper forest soil as is shown by the very old olive, *khanyak* and ash trees which now stand in the middle of the torrent beds.

-As we descend the valley the place of the olive is taken by *bata* (*Periploca aphylla*) and the spiny *acantholimon* with thin overgrazed grass of good fodder value. Some olive survive as much browsed bushes. The stream beds are broad and stony. The side *nullahs* and the main stream beds some times contained much *Sargassi* grass. Occasionally there are some *Vilva negundo* bushes which are used to protect the occasional fields from the floods. The force of the torrents when filled with storm water must be terrific. The far away hills are dotted with olive and *khanyak* trees.

19-8-1944.

From Fort Sandeman to Manikhwah 26 miles and back. The road leads through bare hills to a flat valley along which the Fort Sandeman water supply is brought from Kapip. To begin with the country is over grazed and stony with some unpalatable bushes of *Withania coagulans* and *acantholimon-Sophora griffithii* and *Sargassi* grass. Beyond Kapip the hills are covered with closely grazed grass in tufts and are dotted with olive trees, some of which survive in the upland valleys, generally as much browsed and mutilated bushes. The country is much more fertile and there are good pastures, all closely grazed but now green. Away from the road are quite fair olive forests at Kapip and Wargisra while Atal Katch forest lies 14 miles away to the south; from which the Fort Sandeman supply of firewood is obtained. At Hassubund there is a graveyard with large olive and *Khanjak* trees which have been protected as the ground is sacred. They are very different from the bush-like trees seen on the way.

Rainfall is heavier and more rain is received from the summer monsoon than is usual. There is no doubt that the valleys and lower slopes were at one time well wooded and that the hills contained an open crop of olive and *khanjak* trees. The road crosses numerous stony dry river beds and everywhere there has been much surface erosion of the soil.

Crossing the watershed to the Manikhwah valley in the Shirani tribal country we passed through the remains of what at one time must have been a very fine and extensive olive forest. The trees are all pollarded, and lopped and browsed or have been cut close to the ground when they have coppiced and have formed much browsed bushes. The forest is grazed chiefly in the winter and no flocks were seen to-day. At Spasta there are wheat fields which, after rain, are inundated by means of channels which lead rainwater from the slopes to terraced and embanked level fields. The northern slopes of the hills are well covered with forest: on the southern slopes are more open olive forests.

Went up into the Manikhwah forest of mutilated olive trees with a few *myrthe* and *sophora* bushes and good grass from 5,500 to about 6,000 feet. Above this the country is very eroded. There are very few young olive bushes where they have occasionally managed to escape from the goat.

Kapip forest area 1,750 acres, between 5,250' and 5,500' on an undulating plateau. Had been heavily grazed and lopped previous to 1940 when it was reserved and nominally closed. The olive are old and had been much lopped and are giving out fresh shoots. There has been little improvement in the grass and there is still heavy sheet erosion. The crop consists of very open mutilated old olive trees with small clumps of grass separated by shale. There are some *sophora* bushes and clumps of *Sargassi* (*Saccharum Ciliare*) grass in the shallow *nullahs*. At the bottom of the forest and in the *guzara* are stumps of trees cut long ago for firewood which usually have coppiced and are now browsed bushes about 2 feet in height.

Near the road the grass is thin and heavily grazed and there are *harmal* plants widely scattered over the shale.

20-8-1944.

Fort Sandeman to Hindubagh 132 miles.

The road lies along an undulating plateau covered with *Haloxylon griffithii*, and *harmal* with occasional bushes of *Withania coagulans*, *Alhagi* and thin grass and some *Sargassi* grass in *nullahs*. It crosses numerous dry torrent beds. There is much surface erosion for the first 12 miles, when the road crosses the Badingzai gap.

PHOTO Kila Saifulla 5,000'. Bare calcareous sandstones and shales, Khavi, Chimber, *Pennisetum Haloxylon*, *Acantholimon*.

22-6-1944. From Hindubagh to Pishin 53 miles.

The road leads along an undulating upland covered with *Artemisia* and *acontholimon* shrubs and approaches the hills which are dotted with *Daphne oleoides* bushes. There are very few *Khanjak* trees on the upland and some *sophora griffithii* and *Withania* bushes. There is a little short grazed grass chiefly Khavi and minute grasses. At Kila Kahn Mehtarzai (7,250') there is a lot of Karez wheat cultivation with rather sloping fields. Here runs the Quetta-Pishin and Zhob District boundry.

The road descends along the Surkhab nala which is bordered by hills of pebble beds with a thin and heavily grazed xerophytic flora, mainly of *Artemisia* and its associates

At Kila Nagangi there are irrigated fields and much browsed *tamarisk*. The whole valley is overgrazed and there is much soil erosion.

Permits for reserved trees are issued by the Tehsildar.

23-6-1944. Halted at Pishin owing to failure of petrol supplies. Went across plain to eroded low hills to N. E. and back.

Where the fields are irrigated they are level and embanked and there is no erosion. The main plateau is very nearly flat and the soil is a sandy loam which carries very poor crops of wheat, short in the stalk and full of camel thorn weeds. Crossed the stream of which the banks are virtual cliffs about 12 feet in height. The land behind slopes up to the hills and has at one time all been cultivated, but is now badly ravined. Fields have gone and are going out of cultivation, ravines are rapidly extending. The hills consist of much eroded infertile bare clay with a very thin cover of much browsed *haloxylon* and *artemisia*. The land is cultivated by tenants-at-will who plough it once after rain, sow wheat broadcast and harrow the field and then leave it. If rains are favourable the crop is good; but if as usually happens, there is drought the crops are very poor. The reason why the fields are not embanked is that the tenants are liable to be turned out at the end of the year. They have no permanent interest in the land and they are not willing to improve it for the benefit of the landlord. He takes no interest in the land and is satisfied to take 1/6th as his share of a very thin crop. He provides nothing towards the cost of cultivation. The tenants have few plough bullocks and use camels and donkeys instead.

The neglect of the land and slack cultivation are the direct causes of erosion, coupled with overgrazing of the hill sides.

24-6-1944. *Popalzai Forest*.

Area 1516' acres, elevation 4,879 feet, reserved since 1890. Free of rights. A *tamarisk* forest, coppiced on a 16 year rotation, each coupe being laid on a map, commencing from 1914. Fellings are in arrears and oldest coupe is 20 years. When the scheme is revised (which should be as soon as possible) the rotation should be 20 years and coupes should be of equal area. It is now customary to cut the trees below the ground, which results in stronger coppice shoots. Areas felled over should be closed for 5 years and then the remaining 3/4 of the forest could be opened to grazing. Along the old water channel the *tamarisk* plants were wet with dew at 9 a. m.

The road to Ohaman runs through a flat plain as far as Killa Abdulla and then starts to climb into the hills which are formed of Khojak shales. Wherever the lower slopes have any depth of soil they have been roughly ploughed and sown with wheat which is now being harvested. the crop being very poor indeed. One can hardly imagine it being worth to plough and sow the hillsides for such very meagre results. The hills are thinly covered with *Artemisia* and are dotted with *Pistacia Khanjak* trees and *Prunus cburnea* bushes. In the stony torrent beds old *Pistacia* trees still survive, the remains of an ancient forest. The whole of the hills are overgrazed and the surface soil has been badly eroded. The stream beds show that floods in the spring of this year came down with terrific violence. The country is in a thoroughly bad state.

The *Pistacia* trees have been preserved because of their fruit and are privately owned. There is a very little *ephedra*, some thorny plants, probably belonging to *Acontholimon* and *Astragalus* classes, some *Alhagi camelorum* and xerophytic shrubs. A very few clumps of thin grass, *erumurus* and *harmal*. Returned from Khojak pass which is in sight of Ohaman and Afghanistan.

The Habibzai *Khushkab* cultivation, at the foot of the hills about 4,800' is not watered. The fields are on slopes and are on a sandy loam. They are ploughed and harrowed and sown with wheat which is left to take its chance of getting enough rain, without any further cultivation or weeding. The crops are very poor one to two maunds per acre. The reason why the slack cultivation is possible is that there are no weeds other than camel thorn to interfere with the wheat.

At Karez Inayat Ullah. Had long talk with Tehsildar Khair Mohammed, Haji Abdul Salam Khan, Haji Malik Musa Khan about tractors and *latt bandi* etc. Also about management of pastures and then went to see land for which tractors are needed. It lies between and below the outlying houses and gardens of the village to north of the road to the station and consists for the most part of Karez land which has borne a crop of wheat this year and would ordinarily lie fallow next. The owner H. A. S. Khan promises to give 150 acres and upto 500 acres in all if needed, on such terms as Government shall decide. He has insufficient bullocks to plough the whole of his land; also he is the owner of orchards which I expect need all the water he can get hold of.

There is no rain gauge. Rainfall is probably about the same as at Pishin. The soil is a loam rather silt like, which gives about 12 or 13 maunds per acre from Karez irrigated land and Tehsildar expects 14 maunds from proper *Khushkab* land depending on the rainfall, as against a small yield of land seen this morning. Average is 4½ maunds. Karez gives 24 maunds.

The torrent bed has undoubtedly increased in size and runs right through the village.

On both sides of the railway there is a salty plain, which is gullied, and along the horizon I counted 25 *devil* dancing merrily. To the South of Sayed Hamid bridge (Mile 38 fr. Quetta) the plain is very badly ravined. On the horizon to the south-west the hills appear to be formed of eroded clays.

The P. A. C. Pishin had suggested that land was suitable for a *tamarisk* forest beyond Karbala village. There is no chance of forest trees being established in the portion I saw; but I was impressed with the ravine erosion on the plateau borders on the Tatin Mallezi stream. Ravines are cutting back rapidly into the plateau, and into the irrigated fields, and in a few years

will do much more damage than they have done already. One of the reasons for this is the practice of cultivating in any one year from 1/4th to 1/8th only of the total land the remainder lying fallow. When heavy rain falls no attention is paid to the fallows, the *latts* which have been mined by rats let the water escape and as this pours into the ravines the ravines eat backwards into fields. The general level of the country is about 40 or 50 feet above the bed of the main line of drainage which makes the rate at which ravines form greater here than is usual in Baluchistan. The land is ploughed by camels, which feed on *alhagi camelorum* and salt plants with the result that they are cheaper to keep than bullocks which require *bhusa*.

26-8-1944.

From Pishin the road to Quetta leads through the most extraordinary barren eroded clay hills which must be mud heaps in the rains. There are a very few *Artemisia*, *acantholimon* and some unidentified plants but otherwise the hills are absolutely naked. Below them the valleys have a few grasses *Eragrostis* spp. being the most common, some *Artemisia* and *Salsola* and lower down some *tamarisk* and *Alhagi camelorum*. Eventually nature would clothe the valleys, but many years would pass before the low hills were covered. I doubt if anything can be done to check erosion in the hills: but in the plains *latibundi* is needed.

28-8-1944.

In the plain near Quetta there are ravines near the stream bed. Many of the fields at the lower end of the irrigation channels are very slackly levelled and cultivated and there is sheet and gully erosion.

2-7-1944.

Quetta to Mastung at 5,400'. Sand dunes at Mile 27½ drifting in a S. E. direction in crescent shaped forms with horns pointing in direction in which wind is blowing.

On close examination there is found a number of different species of plants which are endeavouring to gain a footing in face of heavy grazing. Among them are *Sophora griffithii*, *Withania* sp., which is not grazed and is regenerating, *Salsola* and some unidentified plants. *Cyanodon*? a species of couch grass was at one place throwing out shoots over the surface of the sand and forming fresh rooted plants at the nodes. A substantial galvanised iron fence has been erected by P. W. D. to stop sand drifting over the road. Closure to grazing would prevent much of the sand from drifting.

The photographs are of the Shaikhan village now abandoned but shown in 1918 survey map. Sam has covered the fields, destroyed the gardens and has covered many of the abandoned houses, buried the grave yard and choked the *Karez*. The road through Kal State is bordered by undulating cultivated fields of light sandy loam on which wheat grows without irrigation. There is a good deal of soil erosion. The limestone hills are all heavily grazed and are exceedingly barren.

